Academies K

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151

PREFACE.

The Society had two objects in view when it commenced the publication of a fortnightly account of its proceedings, viz., to secure to each member at the earliest opportunity an authentic record of any important communication he might make, and to give an interest to those who, from any cause, might be prevented from being present at the meetings. The Council believe that these objects have been in a great measure attained, and that the Society has been thereby benefited. They have been encouraged by the universal approbation of the members, and by seeing their example copied by kindred institutions. Three Sessions having elapsed, it is thought desirable to bind the Proceedings in a volume, and to furnish an Index for reference. The quantity of matter will be found to have increased each Session, but the Council will endeavour to keep the original intention of the Society strictly in view, and to publish only that part of the conversations which appears to be the most interesting, and abstracts of Papers sufficiently short not to forestall the more important publication of the Memoirs of the Society.

PLATES.

I.—Illustrative of Mr. Ransome's Improvements in Air Pumps, p. 181.

II. and III.—Illustrative of the Oblique Belt on Jupiter, observed by Messrs. Long and Baxendell, p. 225, and p. 253.

INDEX.

Atkinson J.—Height of Atmosphere, p. 67. Erosion of Boilers, p. 101 Fossil at Runcorn, p. 164.

Baxendell J., F.R. A.S.—Donati's Comet, p. 65. Solar Spots, p. 104, p. 160. Barometric Pressure on Nov. 10, 1859, p. 166. Direction of a Storm Indicated by Meteors, p. 171. November Wave of Barometric Pressure, p. 171. Rotation of Jupiter, p. 185. New Variable Star, p. 197. Zodiacal Light, p. 222. Theory of Rain, p. 236. Oblique Belt on Jupiter, p. 225, p. 253, p. 257.

Binney E. W., F.R.S , F.G.S.—Lighting of Mines, p. 13. Scales of Fishes, p. 66. Toadstone of Doveholes, p. 74. Sewage, p. 79, p. 80. Brooches and Ornaments from Morocco, p. 85. Lias Deposits near Carlisle, p. 96. Corrosion of Boilers, p. 103. Discovery of Microphotography, p. 112. Markings on Sandstone near Runcorn, p. 165. Auriferous Veins of Seathwaite, p. 168. Building Stones used in Manchester, p. 190.

Bowman H.—Temperature of Winter Months, p. 231.

Bright Sir C.—Atlantic Cable, p. 64.

Brockbank W.—Titanium from Iron Furnaces. p. 99.

Brothers A.—Photography of Microscopic Objects, p. 176.

Buchan L.—Fall of Rain in 1857, p. 13, p. 22. Fossil Fishes, p. 66. Obituary Notice of, p. 144, p. 246.

Calvert F. C., Ph.D., F.R.S.—Rain Water in Paris, p. 13. Hardness of Metals and Alloys, p. 41. Specific Gravity of Alloys and Amalgams, p. 44. Mercury for Thermometers, p. 67. Sewage, p. 79. Gutta Percha, p. 112. Arnaudon's Researches on Colouring Matters, p. 145, p. 150. Products of Putrifaction, p. 230.

Carrick T.—Unexplained Cosmical Phenomena, p. 105. Relation between Orbit Distances and Orbit Inclinations, p. 162. Sun's Orbit Plane, p. 187. Moon's Orbit Plane, p. 211.

Caw, J. Y.—Motto of Manchester Corporation, p. 7.—Memorial to, p. 66.

Cawley, C. E., M. Inst., C.E.—Rainfall, p. 29.

Christie R. C., Prof., M. A.—Velocity of Wind, p. 67.

Clay C., M.D.—Atlantic Cable, p. 74.

Cockle M. A., F.R.A.S.—Researches in Higher Algebra, p. 62, p. 173.

Curtis M.—Rainfall, p. 13, p. 21. Rain at Manchester from 1786 to 1857, p. 68. Rain in 1858, p. 105.

Dancer J. B., F.R.A.S.—Spines of the Aphrodita, p. 215. Marine Aquarium, p. 228.

Dickinson W. L.—Eclipse of the Sun, March 15, 1858, p. 7. Eclipse of the Sun, July 18, 1860, p. 206. Occultation of Jupiter, p. 244.

Dyer J. C., V.P.—Launching of the "Leviathan," p. 15. Imponderable Matter, p. 91. Generation of Heat by Agitation of Water, p. 93. Remarks on Jevons's Paper, p. 172.

Ekman F., Librarian.—Library of the Society, p. 94, p. 133. Jobert's Works, p. 134.

Fairbairn W., LL.D., F.R.S, President.—Mines Lighted by Gas, p. 13. Strength of Alloys of Nickel and Iron, p. 35. Temperature of England and Italy, p. 45. Density of Steam, p. 70. Corrosion of Steam Boilers, p. 90. Allan's Submarine Cable, p. 112. Effect of Pressure on Gunpowder, p. 117. Iron for Cannon, p. 141. Continuous and Self-acting Railway Breaks, p. 178. Strength of Iron Ships, p. 200. Memoir of J. Kennedy, p. 231.

Fothergill B.—Corrosion of Boilers, p. 103.

Fryer A.—Tea from the Hymalayas, p. 99. Lightships and Lighthouses, p. 196.

Gaskell Rev. W., M.A.—Buonaparte's offer of Services to the English, p. 101.

Gisborne F.—Atlantic Telegraph, p. 226.

Graham J., V.P.C.S.—Consumption of Coals, and Rate of Evaporation from Engine Boilers, p. 29. Inventions in Printing and Dyeing, p. 216, p. 226.

Harley Rev. R., F.R.A S.—Method of Symmetric Products, p. 122.

Heelis T., F.R.A.S.—Tracks of Storms, p. 169. Old Work on Wind, p. 199. Observations of the Sun, by Hevelius, p. 255.

Hepworth J.—Dimensions of Fibrous Materials, p. 228. Mounting Insects, p. 257.

Hopkins Thos., V.P.—Account of Rain in 1855, 1856, and 1857, p. 1. Rainfall, p. 13, p. 22. Improvement in Meteorological Registration, p. 22. Sewage, p. 80. Weather, and the Causes of its Changes, p. 81. Winter Temperature of Britain, p. 153.

Hull E., B.A., F.G.S.—Vestiges of Glaciers in the Highlands, p. 204, p. 212.

Hunt E., B.A. Nitrate of Ammonia in Rain Water, p. 13.

Jevons W. S.—Geology of Australian Gold Fields, p. 134, p. 166.

Johnson R.—Hardness of Metals and Alloys, p. 41. Specific Gravity of Alloys and Amalgams, p. 44.

Jones Rev. H. H., F.R.A.S.—Spots on Jupiter, p. 15. Rain at Rugby, p. 25, p. 59. Height of Atmosphere, p. 67. Obituary Notice of, p. 125.

Joule J. P., LL.D., F.R.S., V.P.—Expansibility of Gutta Percha, p. 65. Correction of "Earth Currents," p. 66. Dalton's Determination of Expansion of Air, p. 67. Velocity of Wind, p. 67. Utilization of Sewage, p. 75, p. 81. Heat, Immaterial, p. 93. Polished Iron Rust, p. 137. Total Heat of Steam, p. 175. Test for Steam Boilers, p. 175, p. 233. Efflux of Air, p. 233.

Kirkman Rev. T. P., M.A., F.R.S., Hon. Mem.—Triedral partitions of the x-ace, and the triangular partitions of the x-gon, p. 11. Fellowships at Owens College, p. 12. General Solution of Problem of Polyedra, p. 25. Tactic Calculus, p. 28. Absurdity of Ontology and Vanity of Metaphysical Demonstrations, p. 38. New Formula in Polyedra, p. 41. j-nodal k-partitions of the r gon, p. 113.

Long I. W., F.R.A.S.—Disk of Jupiter, p. 199, p. 225.

Lowe G. C.—Compensated Pendulum, p. 218.

Lynde J. G., F.G.S.—Strength of Cast Iron Girders, p. 156. Photography of Microscopic Objects, p. 176. Circulation of the Valisneria, p. 214.

Mc. Connell W.—Erosion of Boilers, p. 103.

Mc. Dougall A.—Sewage, p. 79, p. 80.

Molesworth Rev. W. N., M.A.—Social Laws, p. 122. Politico-Economical Doctrines, p. 203.

Moore J., F.L.S.—Obituary Notice of, p. 49.

Morris ——.—Resistance of Ships, p. 87.

Mosley G.—Microscopical Examination of Flour, p. 259. Marine Aquaria, p. 261.

Nicholls J. A., F.R.A.S.—Obituary Notice of, p. 144.

Ormerod H. M., Treasurer.—Oxydized Iron Injuring Buildings, p. 136.

Parry J.—Microscopic Photographs, p. 177, p. 215.

Pearson R. W.—Applications of the Chromates of Potash in Metrical Analysis, p. 4.

Ransome A.—Medical Meteorology, p. 234.

Ransome J. A., F.R.C.S.—Gutta Percha, p 112. Improvements of Air Pumps, p. 181.

Roberts R., M. Inst. C.E.—Launch of the "Leviathan," p. 17. Laying of the Submarine Cable, p. 17. Tunnels for Sewage, p. 80. Pharology, p. 109.

Roberts W., M.D.—Effect of Food on the Reaction of Urine, p. 137.

Roscoe H. E., B.A., Ph.D., Sec.—Arsenical Paper Hangings, p. 91. Bunsen's Analysis of Gunpowder, p. 119. Silurian Schist, p. 168. Arsenic Eating in Styria, p. 227.

Secchi Prof.—Solar Spots, p. 74.

Schunck E., Ph.D., F.R.S., Sec.—Colouring Matter Obtained from the Leaves of the *Polygonum Fagopyrum*, p. 1. Barometric Pressure, November 1, 1859, p. 156.

Smith J., M.A.—Cause of Colour, p. 147.

Smith R. A., Ph.D., F.R.S., V.P.—Derivation and Composition of Rosolic Acid, p. 13. Electrical Experiments in the Thames, p. 66. Sewage, p. 79. Armstrong's Gun, p 108.

Spence P.—Coprolites, p. 3. Inflammable Gas of Mines, p. 13. Sewage, p. 80.

Thomson W., Prof., LL.D., F.R.S., Hon. Mem.—Phenomena of Submerged Atlantic Cable, p. 60. Atmospheric Electricity, p. 108. Electric Telegraph Apparatus, p. 120. Apparatus for Atmospheric Electricity, p. 151, p. 156. Electro-geodesy, p. 152.

Turner Rev. W.—Obituary Notice of, p. 144, p. 246.

Vernon G. V., F.R.A.S.—Meteorology of Manchester, p. 45. Medical Meteorology, p. 234.

Ward F. O.—Pseudo-diascope, p. 172. Safety of Powder Mills, p. 172.

Wilkinson T. T., F.R.A.S.—Folk lore of Lancashire, p. 16, p. 18. Geometrical Investigations by H. Buckley, p. 86. Mathematical Researches by Lawson and Wildbore, p. 121. Life of Henry Buckley, p. 213.

Williamson S. W.—Solar Spots, p. 162, p. 225.

Woodcock A. B.—Gutta Percha and India Rubber, p. 64.

Woolley J.—Obituary Notice of, p. 50.

Worthington R., F.R.A.S.—Cast Iron Pans from China, p. 226. Occultation of Jupiter, p. 256.

Reports of the Council, April 20th, 1858, p. 49; April 19th, 1859, p. 124; April 17th, 1860, p. 246.

Manchester. Literary and Philosophical Society
ac. 1360/2

PROCEEDINGS

OF

THE LITERARY AND PHILOSOPHICAL SOCIETY.

1858—1859. No. 1.

Ordinary Meeting, October 5th, 1858.

Dr. J. P. **Joule**, Vice-President, in the Chair.

The **Chairman** communicated the following extract from a letter received by him from Professor W. Thomson, Honorary Member of the Society, &c., dated Valencia, September 25th.

"Instead of telegraphic work, which, when it has to be done through 2,400 miles of submarine wire, and when its effects are instantaneous interchange of ideas between the old and new worlds, possesses a combination of physical, and (in the original sense of the word) *metaphysical* interest, which I have never found in any other scientific pursuit—instead of this, to which I looked forward with so much pleasure, I have had, almost ever since I accepted a temporary charge of this Station, only the dull and heartless business of investigating the pathology of "faults" in submerged conductors. A good deal that I have learned in this time has, I believe, a close analogy with some curious phenomena you have described, and which you partially shewed me last winter, regarding intermittent effects of resist-

BRITISH MUSEUM

ance to the passage of an electric current between two metal plates in a liquid. Thus I have been informed by Mr. France, of the Submarine and Mediterranean Companies, who has had long experience in testing and working submarine cables, that he has frequently observed, when applying constant electromotive force to one end of a submerged cable in which there is a bad defect of insulation, that the indicating needle of his galvanometer has continued oscillating through nearly the whole range of its scale without any apparent cause. Phenomena of the same kind, to a greater or less degree are, I believe, familiar to all careful observers who have been engaged in submarine telegraphing. Another very remarkable feature of the insulation of gutta percha covered wire, is the difference in the effects of positive and negative electrifications.

"It is well known that a fault of insulation in an actually submerged cable causes a much greater loss of current when the wire is negatively, than when it is positively electrified, and that if after the wire has been left to itself, or has been negatively electrified for some time, a positive electrification be applied and maintained, the insulating power (resistance to loss) gradually rises, and continues rising, minute after minute, and sometimes even sensibly for hours; as is shown by the current from the battery at one end of the cable, gradually diminishing, while the current through the other end, if put to earth, gradually rises in strength. On the fourth day after the end of the cable was landed here, I found that a positive current entering from ten cells of a constant battery fell in the course of a few minutes to half strength. When the battery was next suddenly reversed, the negative current rose, and remained after that nearly constant, at about the same degree of strength as that at which the positive current had commenced. The same kind of action is, I have learned, certainly observed in cables actually submerged, and known to have faults in the gutta percha, by which the conductor becomes exposed to the water, and this has been attributed to electrolytic action upon the water giving rise to oxydation, or to the evolution of hydrogen at the surface of the copper, according as it is positively or negatively electrified, relatively to the earth at the spot.

"I had observed the same difference as to insulating power, for positive and negative charges, at Keyham, the cable being dry, and therefore think that the electrolytic explanation is either insufficient, or implies a very remarkable electrolytic action on gutta percha itself, or on pitch, or possibly moisture in crevasses.

"In some experiments on artificial faults placed in basons of sea water, I have paid particular attention to the green and white incrustations, observed according as the current is from imperfectly protected wire to water or the reverse. The latter is very remarkable, and appears like an exudation on the bark of a tree, when the fault consists of a minute incision or aperture. In the last case there is always a fine passage or crater in the middle, by which bubbles of hydrogen escape."

A Paper by James Cockle, M.A., F.R.A.S., &c., entitled "Researches in the Higher Algebra," was read by the Rev. R. HARLEY, F.R.A.S.

"The author, after adverting to the complexity of the results of the higher algebra, proceeds to simplify some of them. For this purpose he employs a set of canonical functions of the unreal fifth roots of unity, and a certain system of six-valued functions of the roots of an equation of the fifth degree. Availing himself of one of the trinomial forms to which Mr. Jerrard and Sir W. R. Hamilton have shown that the general quintic may be reduced, he has, by an indirect process, succeeded in obtaining the actual expression for the equation of the sixth degree to which that system leads. The resulting sextic is of a simple and, viewed by the light of Mr. Jerrard's discoveries, of a comparatively general form. So that the paper may be considered as presenting, on the one hand, the type of a class of equations of the sixth degree whose finite algebraic solution may be effected by means of one of the fifth, or, on the other hand, as offering a resultant of the sixth degree, the simplicity of which may remove obstacles to the discussion of its solvibility. Under the latter aspect the author suggests that his final sextic may perhaps throw light upon the question of the solvibility of others which occur in the theory of quintics."

"In a Postscript to the above paper dated September 10th, 1858, the author indicates the paths which may be pursued in ulterior investigations. He states that Mr. Harley, in some as yet unpublished labours, has verified several of the co-efficients of the equation in θ and introduced improvements into the general theory."

"In a second Postscript dated September 22nd, 1858, the author points out that the general solution of a given equation of the fifth degree may be made to depend upon that of the equation in θ."

Quarterly Meeting, October 19th, 1858.

W. Fairbairn, F.R.S., &c., President, in the Chair.

Mr. Charles Sever and Dr. W. P. Harrison were elected ordinary members of the Society.

It was moved by Mr. **Curtis**, seconded by Dr. **Satterthwaite**, and resolved, "That inasmuch as the Council of the Society had resolved that due notice not having been given of the alteration of Rule 27 (which was voted at the last Annual Meeting), such alteration fell to the ground, the same be entered on the minutes of the Society."

The **Chairman** having remarked that he had been informed by Sir C. Bright that the Atlantic cable had been submerged in an imperfect state, some surprise was expressed that so important a duty as the construction and care of the cable had been neglected by the engineer. In explanation it was alleged that Sir C. Bright was only employed to superintend the submersion of the cable, but had nothing to do with its manufacture or the care of it previous to embarkation. Mr. **Dyer** thought that the apparatus employed was not such as would ensure the cable to lie evenly on the bed of the ocean, and suggested a plan to remedy this defect. Mr. **Woodcock** believed that the circumstance of the cable lying exposed to the sun's rays at Keyham was fully sufficient to account for its bad insulating power. The action of long continued high temperature was to destroy the pliability and elasticity of gutta percha. The mere weight of the super-imposed coils would tend in time, especially at a high temperature, to cause an alteration in the position of the conducting wire with respect to the gutta percha. Referring to india rubber he remarked its very great expansibility at a high temperature, and in the vulcanized state its great permanence as a spring. He instanced the valve on the air pump of a steamboat which was found to be in a perfect state after the ship had steamed 100,000 miles. Dr. JOULE drew attention to the great expansibility by heat of gutta percha even at a comparatively low temperature, and suggested that a series of alterations of temperature would produce a strain on that material when enclosed in an envelope of inferior expansibility as in the case of the Atlantic cable, which might occasion partial disintegration.

Mr. BAXENDALE described the appearance of Donati's comet seen through Mr. Worthington's 13-inch reflecting telescope. He had not observed the spiral emanations from the nucleus noticed by Mr. Hind. There were several envelopes partly surrounding the nucleus. Latterly the nucleus had increased in brilliancy and become of a purer white. At the period of its greatest brilliancy the tail was 36° long and 12° broad near its termination. The CHAIRMAN and the Rev. H. H. JONES, both of whom had seen the comet of 1811, considered that of the present year far superior to it both as to size and brilliancy. Mr. BAXENDALE remarked that he had observed the comet recently discovered in Cambridge, U.S. It was in the constellation Aquarius, and visible, under favourable circumstances, to the naked eye. Mr. JONES believed that comets were for the most part strangers to our system,—but that wandering through space they might occasionally be drawn by the sun's attraction and thus become members of the solar system for a time, or even in some cases permanently. He contended that the nebular hypothesis offered the best solution of astronomical phenomena.

Ordinary Meeting, November 2nd, 1858.

J. C. Dyer, Vice-President, in the Chair.

The design for a memorial proposed to be erected in St. Andrew's Church, Ancoats, in memory of the late John Young Caw, F.S.A., F.R.S.L., having been exhibited to the Meeting, Professor **Christie** intimated that he would receive any subscriptions towards it which might be offered by the Members.

Mr. Buchan having communicated a notice of the discovery of a large quantity of fossil fishes in Perthshire, in a state of very beautiful preservation, Mr. **Binney** drew attention to the indestructible nature of the enamel forming the scales of some fishes, and to this circumstance he attributed the generally very perfect preservation of fossils of this class.

A conversation ensued on the Atlantic cable. The **Chairman** insisted on the imperfect mechanical arrangements which had been adopted for its submersion. He also considered that it would have been better to land its end in a more sheltered situation than Valencia Bay, such as, for instance, the harbour of Cork. Dr. **Smith** drew attention to experiments recently made in the Thames, which were said to prove that a current of water, passing a submerged wire, induced currents of electricity in the latter. The experiments of Faraday had shown that a conducting body carried in a direction across the magnetic dip had electric currents induced in it, but in experiments on the water flowing under Waterloo Bridge this effect was too small to be appreciated even by that able physicist. Doubtless feeble currents exist according to Faraday's law, but it is difficult to show why they should affect a submerged conductor unless the latter is imperfectly insulated. Dr. **Joule** suggested that the interference of "earth currents," in a submerged conductor, with telegraphic signals, might be obviated by employing a return wire instead of the ocean in order to complete the circuit.

A Paper was read by Dr. Joule, entitled "Note on Dalton's Determination of the Expansion of Air by Heat." Regnault, following Rudberg and Gilbert, had attributed to Dalton an error in reducing his experiments on the expansion of air between 55° and 212° Fahrenheit to that from 32° to 212°. The Author showed, by reference to Dalton's published papers, that his commentators had entirely misunderstood the real facts, the truth being that Dalton in stating that his coefficient coincided with Gay Lussac's, referred to some unpublished experiments which he had made subsequently to those described in the Manchester Memoirs. The experiments of Dalton justified him in drawing the approximately accurate conclusion that all elastic fluids under the same pressure expand equally by heat; the importance of which law to the theory of heat was at once obvious to his sagacious mind.

In the conversation which ensued, Professor Calvert pointed out the necessity of employing perfectly pure mercury in the construction of thermometers. The presence of a very minute quantity of tin would alter its conducting power very considerably, and probably the uniformity of its rate of expansion. The Rev. H. H. Jones and Mr. Atkinson made some remarks as to the height of the earth's atmosphere, and whether the cause of variation of its pressure arose from waves similar to tidal waves. Mr. Atkinson considered that the greatest variations of pressure were near the surface, while Professor Christie and Dr. Joule, from the phenomena observed on high mountains, and in balloons, were of opinion that the velocity of winds is greatest at high elevations.

Ordinary Meeting, November 16th, 1858.

W. **Fairbairn**, F.R.S., &c., President, in the Chair.

A Paper was read by Mr. M. **Curtis**, being "An account of the fall of Rain at Manchester from the year 1786 to 1857 inclusive." By Mr. John Curtis.

This Paper was founded on observations made by Mr. G. Walker, Dr. Dalton, Mr. Casartelli, and himself, and was accompanied by Tables showing the amount of Rain collected at Manchester in each month and year, from 1786 to 1857 inclusive, and also the monthly and yearly mean average of the whole.

Mr. Curtis stated that, as Dr. Dalton found Mr. Walker's average to exceed his by about 4 inches in the year, he waited upon him and inspected his gauge, and found his mode of measuring the rain was not susceptible of sufficient accuracy, and on suggesting the same to Mr. Walker, he seemed to acquiesce. For this reason he gave the average of the 72 years, including Mr. Walker's in one table and for 64 years excluding Mr. Walker's in another.

As the situation of the rain-gauge employed and the influence of surrounding objects thereon will produce different results, he prepared the following table to show the mean monthly and yearly fall of rain as registered by each observer of the whole period, and of the 64 years; which latter period is what he recommended, being adopted as nearest correct.

	Walker, 8 years, 1786 to 1793 inclusive.	Dalton, 47 years, 1794 to 1840 inclusive.	Casartelli, 14 years, 1841 to 1854 inclusive.	Curtis, 3 years, 1855 to 1857 inclusive.	Total, 72 years, 1786 to 1857 inclusive.	64 years, 1794 to 1857 inclusive.
	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.
January ...	2·4685	2·257	3·335	2·150	2·4890	2·4915
February ...	2·7499	2·443	2·437	1·946	2·4556	2·4190
March	2·1145	2·308	2·261	1·526	2·2427	2·2588
April	2·3019	2·114	1·697	2·123	2·0536	2.0225
May	3·5103	2·446	2·134	2·376	2·5008	2·3746
June	3·3000	2·691	3·319	3·106	2·8985	2·8483
July	4·5832	3·706	3·793	3·663	3·8187	3·7231
August	4·7499	3·463	3·767	4·356	3·7025	3·5715
September ..	4·2144	3·192	3·103	2·356	3·2552	3·1353
October ...	4·5104	3·754	4·262	3·223	3·9150	3·8404
November...	3·3019	3·712	3·416	2·020	3·5386	3·5682
December...	5·2873	3·437	3·148	2·012	3·5286	3·3088
Total	43·0922	35·523	36·672	30·857	36·3988	35·5620
1st 6 months	16·4451	14·259	15·183	13·227	14.6402	14·4147
2nd 6 months	26·6471	21·264	21·489	17·630	21·7586	21·1473

From the foregoing table it will be seen that Mr. Walker's mean yearly average of 8 years, was	43·0922
That including Mr. Walker's, the mean yearly average of 72 years, was......................	36·3988
That excluding Mr. Walker's, the mean yearly average of 64 years, was......................	35·5620
That Dr. Dalton's mean yearly average of 47 years, was..	35·523

Showing the small difference of ·039 between the two latter averages.

Mr. Curtis thinks it may be assumed that Dr. Dalton was correct in supposing Mr. Walker's returns were in excess of the reality; and for the purpose of arriving at a correct average, it will be safer to omit them and adopt 35·562 as the average fall of rain for Manchester.

The table also shows that, taking the average, April is the driest and October the wettest month in the year. That the fall of rain in the first 6 months of the year, is to that of the last 6 months as 2 to 3. That there is less difference between the two periods in the later returns than in the earlier ones. Whether this progressive diminution of difference between the first and last half of the year is owing to the later returns being for shorter periods, or to some change in the fall of rain, influenced by a change of circumstances, he left for future returns to show.

The following table shows the greatest and least amount of rain which has fallen in every month during the 72 years, with the year in which it fell, and the name of the collector.

		Inches.			Inches.	
January ...	1806	5·851	Dalton	1833, 1838	0·320	Dalton
February ..	1848	6·565	Casartelli	1800	0·440	Dalton
March	1827	6·030	Dalton	1808, 1829	0·180	Dalton
April	1791	4·750	Walker	1842	0·160	Casartelli
May	1792	8.000	Walker	1844	0·090	Casartelli
June	1830	7·055	Dalton	1826	0·200	Dalton
July	1828	11·480	Dalton	1800	0·290	Dalton
August ...	1799	8·740	Dalton	1801	0·730	Dalton
September	1792	9·000	Walker	1804	0·240	Dalton
October ...	1787	9·000	Walker	1817	0·604	Dalton
November.	1825	7·375	Dalton	1805	0·624	Dalton
December.	1792	9·500	Walker	1844	0·070	Casartelli

	INCHES
The largest amount of rain fell in 1792, and was	55·250
The least amount of rain fell in 1826, and was ...	24·910

Mr. Curtis pointed out that the rain which fell from 1793 to 1814 was below the average of the 64 years, from 1815 to 1852 it was above, and from 1853 to the present time it has again fallen below, from which he infers we have entered into a low series, and that, consequently, we may for some time expect it to remain below, though there will doubtless be some few intermixed above it. This variation was clearly seen on a chart he exhihited. He also pointed out the following differences, as seen in his tables.

From 1795 to 1814, inclusive, the mean of the 20 years is 33·044 inches; from 1815 to 1836, inclusive, the mean of the 22 years 38·161; from 1837 to 1852, inclusive, the mean of the 16 years is 36·328; while from 1853 to 1857, inclusive, the mean of the 5 years is only 31·371, showing the correctness of Dr. Dalton's remarks, as to the importance of a long continued series of observations, to obtain a satisfactory table of the mean quantity either for each month or the whole year.

Dr. Joule having taken the Chair, a Paper was read by the PRESIDENT, entitled "Notice of some Experimental Apparatus for Determining the Density of Steam at all Temperatures."

The Author proposed to give a brief sketch of some apparatus which has been recently constructed, in order to ascertain the density of steam at various temperatures; and thus, to correct or verify some theoretical speculations in regard to the relation between the specific volume and temperature of steam and other vapours. The experiments are being conducted, it is believed, on an entirely novel and original principle, applicable at any temperature and pressure capable of being sustained by glass.

For a perfect gas, the law which regulates the relation between temperature and volume is known as Gay Lussac's, or Dalton's law, and is expressed in the equation

$$\frac{V\times P_1}{V_1\times P}=\frac{458+t}{458+t_1}\quad\ldots\ldots\quad(1.)$$

Now the density of steam has been determined accurately for a temperature of 212° Fahrenheit (by the method of Dumas), to be such that its volume is 1,670 times that of the water which produced it. Hence, if the above law be correct for steam, we have for any other pressure, the specific volume

$$=V=\frac{1670\times 15}{670}\times\frac{458+t}{P}\quad\ldots\ldots\quad(2.)$$

From this formula all the tables of the density of steam have been deduced, and all the calculations of the duty of steam engines have been founded on it. Up to the present time, however, this formula has never been verified by direct experiment, nor are the methods hitherto employed in determining the density of gases and vapours applicable in this case, except at the boiling temperature of the liquid under ordinary atmospheric pressure. But, on the other hand, theoretical calculations throw considerable doubt on the above formulæ as applied to steam and other condensable vapours. Several years ago Dr. Joule and Professor William Thomson announced, as the result of applying the new dynamical theory of heat to the law of Carnot, that for temperatures higher than 212° there is a very considerable deviation from the gaseous laws, in the case of steam. Later, in 1855, Professor Macquorn Rankine has given a new formula for the density of steam, independant of Gay Lussac's law, and this confirms Mr. Thomson's surmise. Still these speculations need the confirmation of direct experiment.

The density of steam is ascertained by vapourizing given weights of water in a glass globe of known capacity, and noting the temperature at which the water disappears and fills the vessel in the form of steam. Two difficulties, however, have to be overcome. First, the pressure of the steam renders it necessary that the glass globe should be heated in a strong, and therefore of necessity, opaque vessel. Second, as steam rapidly expands in volume for any increase of temperature beyond the temperature of saturation, it would, in any case, be impossible to decide by the unaided eye the exact temperature at which all the water became vapourized. The slightest error in deciding the temperature of saturation would vitiate the experiments and render the results of no value.

The difficulty thus resolves itself into finding some other test sufficiently delicate to determine the point of saturation. This has been overcome by what may be termed the saturation gauge, and it is in this that the novelty of the present experiments consists.

The simplest form of the apparatus might be described as composed of two glass globes connected by a bent tube containing mercury, as in the differential air thermometer. Supposing a weighed portion of water introduced into one of the globes, and any larger portion into the other, and the apparatus placed in a bath and slowly heated, the pressure in each globe would increase equally up to the point at which all the water in one globe became vapourized. As soon as the saturation point in this globe was reached, the mercury column, up to this time level, would rise in the stem of that globe in which the pressure had almost ceased to increase. The instantaneous change of the position of the mercury is the indication of the temperature of the steam when saturated. Thus, at 290° Fahrenheit, the mercury column would rise nearly two inches for every degree above the saturation point, as the increase of pressure arising from vapourization is twelve times that arising from superheating or expansion, and a similar difference exists at other temperatures.

The Author described one of the forms of apparatus by means of a diagram. It consists of a glass globe with a long stem placed in a copper boiler, fitted with blow-off cock, steam gauge, thermometer, and gas jets for heating. The stem of the globe passes down a glass tube depending from the boiler, and forms the saturation gauge.

Some results have already been obtained, both by this and by another form of apparatus, but they need further confirmation before they are made public. Hitherto, the Author had been chiefly engaged in overcoming those practical difficulties which beset the commencement of all new methods of experimenting, especially where such extreme accuracy and delicacy of manipulation are essential.

The experiments had been arranged with the co-operation of Mr. Thomas Tate, F.R.A.S., and were being carried out with great care by the Author's assistant, Mr. Unwin, under his own immediate direction, and he hoped for results of high scientific importance and great practical utility.

Ordinary Meeting, November 30th, 1858.

J. C. Dyer, Vice-President, in the Chair.

A remark having been made relative to the spots on the sun's disc which had of late been sufficiently large to be visible to the naked eye, by the simple use of a smoked glass, Professor **Calvert** noticed the researches of Secchi, proving the extraordinary influence on terrestrial magnetism which is occasioned by such spots.

Dr. **Clay** exhibited a specimen of the Atlantic Cable. The gutta percha had gradually contracted in length until the iron wires projected considerably beyond it. He considered that this fact might throw light on the cause of the rupture of the gutta percha and consequent loss of insulation which had taken place.

Mr. **Binney** made the following communication respecting the Toadstone of Doveholes. For many years Doveholes, near Chapel-en-le-Frith, has supplied the City of Manchester with lime, and the Peak Forest Canal was made chiefly for the transport of that article. Doveholes not only yields limestone, but very hard Dunstone, or Toadstone, the provincial names of trap rock in Derbyshire, suitable for paving and road making. The Derbyshire traps are very variable in their nature, some being quite soft, whilst others equal in hardness the toughest Whinstones of Scotland. The Doveholes stone belongs to the latter class. On examining the quarry there, the other day, in company with Professor Roscoe, of Owens College, I found the beds to occur in the following descending order:—

	Ft.	In.
Surface and lime rubbish........................	2	0
Limestone with an uneven under surface ...	2	6
Greenish brown clay	6	0
Hard Toadstone, exposed	12	0

It is singular that this Toadstone has never been introduced into Manchester for paving and road making, but that all such materials are fetched from Penmaen-mawr, in North Wales, when they could be had within a quarter of the distance from Derbyshire by rail and canal. As a quarry is now opened in Doveholes, and the stone to all appearance is as hard as the Welsh stone, it is desirable that the authorities of Manchester and Salford should give the Toadstone a trial, and test its capabilities of standing the wear and tear of our main streets as a paving stone or road metal. Both the Welsh and Derbyshire stones are of igneous origin, and have a nearly similar composition.

Dr. ROSCOE stated that he intended to analyze the Derbyshire traps, and hoped shortly to lay the result before the Society.

A Paper was read by Dr. JOULE "On the Utilization of the Sewage of London and other Large Towns." The Author having given an outline of the history of the question of Metropolitan drainage, expressed his regret that a system had been adopted in which the utilization of the sewage was ignored, and only the second object, that of increasing the salubrity of the Metropolis, was considered. He described the works which are now being attempted, and came to the following conclusions:—1st. That under the new system greater accumulations of deposit would take place, which, being carried into the river by storm overflow, would continue to pollute the Thames. 2nd. That the new sewers, being composed of brick, would not entirely prevent the percolation of sewage into the adjacent ground. 3rd. That the portion of sewage discharged at the outfalls would not be entirely prevented from returning to the Metropolis. 4th. That the river would be rendered particularly noxious at the point where so vast a quantity of offensive matter was to be concentrated; and, in consequence, the large floating population, as well as the inhabitants of Greenwich, Woolwich, Gravesend, &c. would suffer most severely. 5th. That the air confined in the new mains would seriously increase the already enormous volume of putrid gases in the sewers, and which was already so great a nuisance. 6th. That the system as well as that which it was to supplement, could not be considered otherwise than as very filthy; inasmuch, as instead of removing the sewage to the soil, which is the natural deodorizer, it wonld cause its accumulation in the bed of the river at only a few miles distance.

The above were some of the principal reasons why the Author believed that the plan of the Board of Works would fail to promote the object for which that which ought to have been the primary consideration had been neglected. He would now endeavour to show the practicability of utilizing sewage, and at the same time of cleansing large towns. In the first place, however, it was desirable to reiterate the scientific facts, which proved not only the importance but the absolute necessity of putting a stop to the present waste. Liebig states that, "In the solid and liquid excrements of man, and of animals, we restore to our fields the ashes of the plants which served to nourish these animals. These ashes consist of certain soluble salts and insoluble earths, which a fertile soil must yield, for they are indispensable to the growth of cultivated plants. It cannot admit of a doubt, that by introducing these excrements to the soil, we give to it the power of affording food to a new crop, or, in other words, we reinstate the equilibrium which has been disturbed. Now that we know that the constituents of the food pass over into the urine and excrements of the animal fed upon it, we can with great ease determine the value of various kinds of manure. The solid and liquid excrements of an animal are of the highest value as manure for those plants which furnished food to the animal."

From the above incontestable principle, the Author showed that *the daily waste occasioned by the enforcement of the present system on the inhabitants of London, is equivalent to* 2,723 *tons of butcher's meat, potatoes, and bread; and* 860,000 *gallons of milk, beer, and other liquid food*, a loss which would speedily reduce the country to a state of barrenness, were it not for the importation of large quantities of food and manure from foreign countries. But guano would not last for ever. If the produce of the Chincha Islands, which afford it most abundantly and of the best quality, were reserved for the sole use of Britain, they would be exhausted in sixty years at the present rate of consumption. Then as to the importation of cattle, corn, and bone manure; such supplies would continue only so long as foreign governments remained ignorant of the permanent injury inflicted on their fields. Liebig has already complained that, if the exportation of bones continued at the present rate, the German soil would become gradually exhausted.

The Author, moreover, insisted that we ought not to be satisfied with merely keeping our agriculture from decline; but that, with a rapidly increasing population, the wisest course would be to reserve such supplies of guano as we may be able to obtain, for the purpose for which it would seem to be designed by nature, that of forming a fertile soil where sterility at present exists.

The first step with a view of putting a stop to the present waste, would be to prohibit the needless introduction of organic matter into the sewage. For instance, slaughter-houses should only be permitted in the country, and even there should be placed under such regulations as would secure the proper disposal of the blood and offal. Then again, the drainage of intramural burial grounds was enjoined by Act of Parliament, and thus the pollution of sewers was considerably increased. The body, after death, ought, in accordance with the Divine ordinance, to be permitted to return to the dust whence it was taken, and for this purpose should in all cases be placed at a moderate depth beneath a soil bearing a vegetable growth. In considering, secondly, what should be done with the sewage proper, it must be observed that the large quantity of water mixed with it prevented its being used effectively for agricultural purposes. By the lime, and other processes of precipitation, not more than one-third of the fertilizing constituents could be separated. It was obvious, therefore, that the sewage should be dealt with before it became diluted with rain and other comparatively clean water. Consequently there appeared to be no alternative but the adoption of an improved system of cesspool drainage. The Author would divide a town into districts, each containing about fifty houses or four hundred inhabitants. Each district to possess a cesspool, situated if possible in the centre of the street. Drains at great inclination, and in connexion with the water-closet pipes, to discharge themselves into it. He would place a force-pump permanently in each cesspool, along with an agitator to operate by revolving on its axis. Tanks, suited to hold the contents of two or more cesspools, to be provided, into which the sewage collected during the day should be pumped every night, when a portion of Mc'Dougall and Smith's disinfecting powder might be introduced. The tanks to be then conveyed by railway, and their contents thrown into reservoirs placed in suitable localities. It would be convenient to employ a traction engine to draw the tank, which might also be employed for pumping and working the agitator. In some cases it might be useful to prevent gritty matter coming in contact with the piston or plunger. This could be readily effected by placing an elastic diaphragm in an expanded chamber beneath the piston. A filter placed above the diaphragm would prevent any but clear water coming in immediate contact with the piston. The advantages claimed by the Author for the proposed plan were—1st. Easy construction and repair;

2nd. Each drain and cesspool, being entirely independent of the rest, might be placed in the most convenient situation; 3rd. Percolation of sewage into the ground would be completely prevented; 4th. The entire sewage would be completely removed every day; and 5th. The whole of it would be utilized.

In the conversation which followed the reading of the Paper, Mr. Mc'Dougall commented in strong terms on the system pursued in Manchester, whereby dung-heaps and the putrified refuse of slaughter-houses were exposed to the open air for weeks together.

Dr. Smith deprecated any return to the cesspool drainage, citing Paris as an instance of the nuisance thereby created. Professor Calvert considered that the Paris system was wholly different from that recommended in the Paper, the chief merit of the latter being, that the cesspools were cleaned out every night, and in such a manner that no nuisance could arise.

Mr. Binney stated that Dr. Joule's plan resembled, in some respects, that of Mr. Glassford, who, by the introduction of a new description of water-closet, was enabled to pass the sewage in a concentrated form down pipes of very moderate inclination.

Ordinary Meeting, December 14th, 1858.

W. Fairbairn, F.R.S., &c., President, in the Chair.

The conversation on the subject of Dr. Joule's Paper was resumed. Mr. Spence insisted upon the advantage which would result if the system he had proposed some months ago, that of disinfecting sewage by introducing the products of combustion from chimneys into the sewers, were adopted. He hoped to be able to make an experimental trial at his works shortly. Mr. Binney stated that he had reported on the condition of the rivers of Manchester twenty years ago, but the Corporation had gone on sewering into the streams ever since, and this system had been copied, with pernicious effects, by the neighbouring small towns. The streams were now everywhere thoroughly contaminated. Mr. Hopkins explained what had been done in Manchester, and alluded to the evil which arose from the large number of exposed middens. He considered it an important feature of Dr. Joule's plan, that it could be tried on a small scale. Mr. Mc'Dougall adverted to the enormous deterioration of air, which had been observed by Dr. Smith to have taken place in the confined yards behind houses. He pointed out the great importance of disinfecting sewage, both on sanitary grounds and also to preserve the fertilizing property. In reference to the latter, he mentioned the result of an analysis of urine which had been kept some time after it had been treated with his and Dr. Smith's disinfecting agent. It was found that the urea had not suffered decomposition. But in another untreated specimen, kept for the same period, the urea had become converted into ammonia, of which nearly the whole had been dissipated. Mr. Roberts proposed to build tunnels under the streets. These tunnels might contain the water and gas pipes. On the floor of the tunnels a railway might be placed, by means of which the contents of the receptacles of sewage could be carried away without pumping. Although the first outlay might be considerable, the working expenses of such a system would be comparatively insignificant. Dr. JOULE, in reply to a question which had been put the preceding meeting, stated that he estimated the total annual expense, including interest of capital, which would be incurred by removing the sewage of London to the fields, on his plan, at £1,140,000. The actual value of the manure being £1,440,000, a clear gain of £300,000. might be anticipated. On the other hand, the plan of the Board of Works would involve a dead loss of £230,000, and if the sewage were carried to the German Ocean the loss would be increased to, at least, £500,000. per annum.

A Paper was read by Mr. HOPKINS, entitled, "On Weather, and the Operating Causes of its Changes."

In this Paper the writer does not furnish registered tables of the weather which is found in various places, as is often done by meteorologists, because he considers that an abundance of such documents are to be had in many publications; and so numerous and full are they as to give sufficient information respecting the mere facts, in the order in which they occur annually, daily, and hourly, to enable anyone, by careful analysis and comparison, to trace the forces or laws that pervade and govern the whole, and which give birth to the phenomena that accompany changes of the weather. But *a knowledge of these laws* is what is at present required. Having this object in view, the Author explains what he considers to be the main cause of the great disturbances of the atmosphere which occur, in varying forms, and to different extents, as shown in the numerous accounts which have been given of them over the whole surface of the globe. This cause is stated to be the metamorphoses of water produced by its union with, and separation from, solar heat, which metamorphoses are shown to be almost constantly taking place over every part of that surface. But the operations are complicated, and so far concealed from ordinary observation as to make them somewhat difficult to follow and explain. This is more particularly the case with those alterations that are consequent on the annual revolution of the earth; whilst its daily rotation on its axis, presenting portions of its surface successively to the action of the solar heat, permits the influence of that heat on the water of the earth to be more readily followed and examined. The hourly disturbances of the atmosphere, by solar heat, are therefore first examined; and it is shown that a little before sunrise evaporation of water becomes more energetic, sending vapour into the air which increases the total weight of the atmosphere, and makes the barometer rise without producing other disturbances until, say, ten o'clock. After ten, more vapour is furnished by evaporation, yet atmospheric pressure is not increased, but, on the contrary, diminishes! This diminution is maintained to be caused by ascent of vapour to a sufficient height to be condensed into particles of water by the cold of the gases; and the condensation liberates heat that was contained in the vapour, which heat warms and expands the gases. This expansion, forcing some of the air to go into adjoining parts, renders the locality lighter,—as is palpably shown in many places by a sea breeze, and the falling of the barometer. When the mid-day condensation of vapour is moderate it produces but a slight disturbance, and generally terminates about four o'clock in the afternoon, leaving clouds floating in the air. These clouds then begin to dissolve by evaporation into transparent vapour, taking heat from the gases in the locality, which makes them heavier, and they sink to the surface of the earth where they are generally known by the name of "land winds." The greater weight of this cooled local air makes the barometer rise until about ten o'clock, p.m. But after this hour the absence of the sun permits the earth to cool, and to convert some of the vapour into dew;—and the barometer falls in proportion to the extent to which vapour is thus liquified. Mr. Hopkins, therefore, maintains that total atmospheric pressure is reduced, and the barometer falls from ten at night until four in the morning, because aqueous vapour is then abstracted from the atmosphere; — and that the barometer rises afterwards from four to ten in the day because fresh vapour is then sent into the atmosphere by solar heat. The movements of the barometer during these twelve hours are therefore stated to be results of *varying* VAPOUR *pressure alone*, without any disturbance being produced in the gaseous mass. But from ten in the morning until four in the afternoon the liberated heat of condensing vapour makes the gases in the locality lighter; whilst from four in the afternoon until ten at night they are made heavier through abstraction of heat from them by cloud evaporation, making the fall and rise of the barometer which then take place, effects of *varying* GASEOUS *pressure*. And the last named kind of changes, when sufficiently great, are asserted to cause all the important disturbances that occur in the atmosphere in every part of the world.

Ordinary Meeting, December 28th, 1858.

W. **Fairbairn**, F.R.S., &c., President, in the Chair.

At the commencement of the business of the meeting, the **President** stated that it was his painful duty to announce a loss which the Society had sustained in the sudden and unexpected death of their friend and colleague, the late Reverend Henry Halford Jones, M.A., F.R.A.S., &c. This lamentable occurrence took place on the morning of the 21st inst., and in Mr. Jones's death the Society has lost an intelligent and efficient member. For upwards of twenty years he took an active part in the business of the Society. He served the office of Honorary Secretary from two to three years, in conjunction with Dr. Angus Smith; and on every occasion Mr. Jones, as an ardent lover of science, faithfully and honestly discharged the duties of that office. His scientific attainments, and varied knowledge in literature, enabled him to take an active part in the discussions; and on all occasions he was found able and willing to assist in any pursuit, having for its object the advancement and prosperity of the Institution to which he belonged.

In Astronomy, Mr. Jones was no pretender; on the contrary, he was an accurate observer; and his knowledge of Mathematics, united to a mind possessing powers of generalization, rendered him an instructive and at the same time an agreeable associate and companion.

As a member of the Society, he was always alive and always attentive to its proceedings; and his love of science, strict integrity of character, and other acquirements, rendered him a powerful advocate in every department of mental progress.

It was moved by the **President**, seconded by Mr. **Buchan**, and unanimously resolved, "That this Society has heard with deep regret of the sudden death of the Rev. H. H. Jones, F.R.A.S., and desires to record its high appreciation of his services as one of the Honorary Secretaries and as a member of the Council of the Society for many years; and that this expression of condolence on their sudden and painful bereavement be conveyed to Mr. Jones's widow and family."

Mr. **Binney** brought before the Society some Lithographs of Brooches and Ornaments.

Mr. F. M. Jennings, M.R.I.A., F.G.S., some time since, travelled in Morocco. Whilst there he collected a series of brooches and ornaments in common use in that country. These are very similar in form to specimens of ancient Irish brooches and ornaments now in the Museum of the Royal Irish Academy, and are, in the opinion of the Author, another evidence of the trade anciently existing between the Phœnicians, their Colonies, and Ireland. The drawings exhibited shew the African and Irish ornaments. On shewing these drawings to Mr. Charles James Julote, a Manchester gentleman, who has resided in Morocco, he says, the brooches seen by Mr. Jennings in Morocco, and ornaments with similar designs, are not uncommon in Algeria and Morocco. They are made by *Moorish* and *Jewish* workmen. All the designs I have seen in those countries, which are acknowledged as *Moorish*, have reference to some geometrical figure. Then, in the designs which may be considered Christian, some have waving lines with branches, others have reference to the Cross, like Fig. 1 of Mr. Jennings's drawings. These designs may be traced to Christian workmen (Spaniards, Portuguese, Italians, and Maltese) who have, from time immemorial, occasionally resided in these countries; indeed, many of them have adopted the manners and religion.

The people of Susa consider themselves a distinct nation, have a distinct language, which I have heard somewhat resembles the *Irish.* They used to keep up an intimate relation with the Canary Islands. They say their religion is more Christian than Mahomedan. This statement should be received with doubt. When the Portuguese were driven from the coast, many who had married remained in the country, and professed Islamism.

The above people, of which very little can be learned, owing to the jealousy of the Moors, are an active, intelligent class, sometimes employed by European settlers as trusty servants, and very seldom abuse the confidence placed in their fidelity. They are the celebrated snake charmers, vaulters, skull and choppers, of whom we read; and they are the carriers to Wednoor Mogador. I believe if we could induce the Emperor to allow us to trade to Agadeer, a large and valuable trade from that place to Senegal and Timbuctoo might be carried on. At present it is not safe to enter the country.

Mr. T. T. Wilkinson, F.R.A.S., laid before the meeting a selection of Geometrical Investigations, from the papers of the late Mr. Henry Buckley, of Wood House, Delph. He stated that Mr. Buckley was a pupil of the late Mr. John Butterworth, of Haggate, near Oldham, and was peculiarly distinguished for his knowledge of the Ancient Geometrical Analysis. Amongst the investigations laid before the meeting were several relating to the properties of Bisectant Axes, and their application to the solution of problems. Others related to Porisms, Loci, Tangencies, Sections of Ratio, &c., &c., all of which had important bearings upon the principal subjects of interest amongst the ancient geometricians. Mr. Buckley died in July, 1856, and might almost be considered as the last of the Oldham group of self-taught mathematicians. He corresponded to the *Diary*, the *York Courant*, and the *Educational Times*, both in his own name and under several assumed signatures. Since his death, Mrs. Buckley had consigned the MSS. to the care of Mr. Wilkinson, for publication or otherwise; and on the suggestion of the

President, he promised to make a selection of the most interesting of these geometrical speculations, and offer them to the notice of the Society at no distant period.

A Paper by Mr. Morris was read, entitled, "On the Practicability of Counteracting a Portion of the Resistance at the Head of a Ship, by employing a Revolving Conical-Bow to work a Stern Propeller." Communicated by David Chadwick, F.S.S., Assoc. Inst. C.E.

"The proposed improvement consists in substituting for the lower or submerged part of the bow of a vessel, a cone fixed upon a moveable shaft. The cone is surrounded by spiral flanges, so disposed that the water (when the ship is set in motion by sails or steam-power) may impinge upon the flanges, and cause the cone to revolve. The force thus obtained is transmitted through proper shafting and gear to assist the engine, if a steamer, or to work a stern screw, if a sailing ship.

"Now, as this may, at first sight, look very much like an attempt to obtain something out of nothing, or to produce an effect without a cause, I must solicit your candid attention to the few arguments I shall advance. I would first remark, that in the examination of this plan, it is necessary to bear in mind that it does not profess to be a motive power,—the motion must first come from engine or sails; and secondly, that no more power can be derived from it as assistance at the stern, than is first encountered as retardation at the head of the vessel. Whence, then, it may be asked, arises the advantage? In this way—the resistance in front *has* to be encountered, whatever the form of the ship's head, and whether any use be made of it or not, consequently, if a revolving bow be adopted, which gives no material increase of resistance, then the power derived from its revolution, when set either to assist the engine, or to work an independent screw at the stern, must be so much gain. The question, it will be observed, is not one of displacement, but the *mode* of displacement.

"It has been objected that, 'As the front apparatus is set in motion by the resistance to the vessel's progress, the stern screw can have no propelling power whatever.' Now this, you will perceive, assumes entirely the point in dispute, instead of attempting to prove it. It is indisputable that the action of the water upon the conical screw would cause a large amount of force to be given out by the propeller, and the only way in which this can be rendered nugatory, is to suppose that there would be as much additional resistance generated by the flanges of the revolving bow (which is in reality to suppose that the *mode* of displacement is equal to *displacement itself)* as would be given out by the stern screw. I think the experiments I am now prepared to make, in an artificial stream, will shew that no such increase takes place. The water in front is pressed very little more forcibly by the flanges of the cone than it would be by the cone itself, if the flanges were removed, but the water at the stern *is* pushed with considerable force by the screw, and by a force which increases with the ship's velocity. In one of the small models now exhibited, the revolving bow, in a moderate stream, gives ninety-two revolutions per minute to the propeller.

"No one, at this day, will imagine that any power can be created; but a great deal is lost, and perhaps some may be saved. The ordinary head of a vessel may be regarded as a wedge employed to split open a channel for her. In her voyage, the water is at every moment making an effort to press the two sides of the wedge together, and yet no attempt has been made to economise this constantly-sustained pressure. Now, a cone is a wedge in every direction—a circular wedge—and by surrounding it with spirals, it will become a revolving wedge, the flanges themselves constituting an active part of it. I submit that by driving through the water an immovable wedge, a large portion of the motive power is wasted; but by employing a revolving bow, that wasted portion may be economised. I believe that the result may be thus stated:

Resistance of plain conical-bow 100+10 for resistance of flanges + 5 for friction = 115. Available power, one-half of 100 = 50 — 15 = 35 clear gain. This is upon the supposition that the revolving-cone is only checked to the extent of half the speed due to the resisting water."

Several experiments were then tried.

A laden model was balanced in the stream by a weight, and then a string attached to the shaft of the propeller, which revolved six times the speed of the bow. The string was fastened ahead, and the model wound itself forward. A second model was placed in the stream without a balance-weight, and it pulled itself ahead by a string fastened to the cone-shaft. A craft was then produced (merely as an illustration) with a paddle both at the head and stern, with gearing to increase the speed of the hind-paddle. When this is balanced in the stream, the fore-paddle causes the hind-paddle to revolve, and in doing so it pushes the boat forward by its action against the water at the stern.

In the discussion which followed the reading of the Paper, the PRESIDENT said it was impossible to take power from the water without decreasing the speed of the ship to the extent of the power gained. Mr. MORRIS replied that no doubt that was so; but in this instance the water treated was not that which passed the sides of the vessel, but the very water which she would have to displace by her motive power before she could pass through it. Dr. JOULE thought that the effect of the revolving-bow might in some cases be to make a bad bow better; but denied the possibility of its producing any but a retarding effect if applied to a ship possessing good lines.

Ordinary Meeting, January 11th, 1859.

W. Fairbairn, F.R.S., &c., President, in the Chair.

The **President** exhibited various specimens of the iron of certain locomotive boilers which had been found to have suffered local corrosion of a dangerous kind, after only a few years work. The first specimen was from the boiler of the goods locomotive engine, "Goliah," built by Messrs. Hick and Son, in 1839. It was a part of the fire-box, through which one of the longitudinal stays had passed. The iron (Low Moor) had been cut away by the corrosive action in grooves radiating from the stay as a centre. The second specimen, taken from the same engine, and likewise of Low Moor iron, was from a part which had been rent asunder in the explosion of the boiler in 1847, before the engine was nine years old. A third specimen was from the boiler of the "Bat" goods locomotive, built by Mr. Woods. It consisted of a part of the angle iron ring at the smoke-box end. A deep groove had been formed by the corrosive action, and water escaped through the angle iron after the engine had worked less than six years. A fourth specimen was taken from the passenger locomotive, "Ostrich," built by the Liverpool and Manchester Railway Company. The bottom plate of this boiler, made of Low Moor iron, had been corroded in less than four years to such an extent that water escaped through it. The President observed that these remarkable effects belonged exclusively to locomotive boilers, and had not been noticed in those of stationary engines. He recommended the subject to the attention of the Society as one of scientific interest, as well as great practical importance, indicating, as it did, a source of hitherto unsuspected danger.

A lengthened conversation ensued, some members being of opinion that the phenomena were owing to the vibratory motion of the engine, predisposing certain parts to chemical action. Others thought that currents might exist in uniform directions, by which the part might be kept in that condition, as to cleanliness, most favorable to oxidation. Several members thought that the action was owing to galvanic currents arising from portions of the iron taking the electro-negative condition, which that metal is so apt to assume.

Professor **Roscoe** called attention to the pernicious consequences attending the use of unglazed arsenical green paper hangings. His own experience corroborated the observation of Dr. Taylor, that dust collected in rooms, so hung, contained a large quantity of arsenic. He had analyzed the dust from the shelves, &c. of a room occupied by himself, and had found a considerable quantity of this poisonous substance.

Mr. **Dyer** read a Paper on "Imponderable Matter, considered as an *Element*."

He stated, that about two years ago, his first Paper on the "Nature of Heat," was read before the Society, and he therein maintained that the "Matter of Heat" was not a misnomer, but, in fact, a material element, that pervaded all space and all bodies in the universe; and in its neutral state was identical with the *electrical* and *magnetic* fluids, as also with *light*, or the luminous principle.

Since then, he had read three other Papers, to illustrate and explain his views of elemental heat, and its agency in phenomena, exhibited by its mutations from the elemental state, into and out of the conditions commonly expressed by the terms, sensible, radiating, and latent heat; the present Paper being intended to give a *summary* of the views advanced in the former. For the sake of brevity, his own is treated as a "heat-force theory," to denote its being opposed to the "force-heat theory;" and considering that this latter theory has been advocated by many eminent philosophers among the ancients, as well as the moderns, it would be a great temerity in him to oppose that theory, unless he had some strong grounds of objection to offer to it, as well as those in support of his own views. In explanation of these, he said, the common terms applied to heat in its sensible, radiating, and latent states, do not apply to or convey the meaning he attaches to the term "neutral and elemental heat," which condition he defines to be "an imponderable, elastic element" that permeates, and is *equally* diffused through matter and space, except when its elastic force is exceeded by other disturbing *forces*. Many instances of such disturbing forces were set forth and explained, and in reference to these he observed, "that great confusion had arisen from the vague and discordant senses in which the term 'physical force' is often employed by very eminent physicists." In treating of the "nature" and "conservation" of force, the term is said to mean "that which produces or resists motion," thus implying that force is of itself a substantial existence, whereas it merely indicates *action* among bodies. These exert force upon one another, and upon their own component parts, so that force means exerted action of matter upon matter, and to give it substantial attributes is absurd.

In support of the identity of heat and electricity, many cases were cited.—(1.) That heat ascends latent in aqueous vapour, which being condensed, the latent heat becomes neutral or elemental in the upper regions, and this *because* no substance is present, other than "the thin cold air" with which it can unite, and become sensible heat. This neutral element is the electric fluid, and is made known to us in all the forms of electrical phenomena.—(2.) Again, when water descends through the crevices of the earth down to the incandescent mass, it is converted into steam of great force, causing volcanic eruptions and earthquakes, according to the intensities of the forces so generated, by the union of water with heat. This heat latent in the vapour, ascends and is liberated in the upper air, and flashes forth as lightning, always attending those convulsions and proving the identity of the calorific element with the electrical phenomena so exhibited. It was stated that his (Mr. Dyer's) heat-force theory was in strict accordance with Dr. Black's latent heat doctrine, and that it went to support it, and to explain some anomalous cases that had been adduced against the beautiful system of latent heat so long an established basis of wide ranges of phenomena, alike in nature and in art. Considering that the "force-heat theory" is inconsistent with Dr. Black's, and as this latter is embodied on most of the standard works on physics, it should not be abandoned to make way for another theory that fails to account for such phenomena. Apart from the mutations of heat from chemical changes, the mechanical action of the earth's movements was described as exhibiting magnetic and luminous phenomena, by the movements of elemental heat, proving these also to be identical with it, and with electricity. He then proceeded to show the sameness of light and heat, as proved by the many incontrovertible instances advanced of their inseparable connection, and mutual convertibility into each other; and thus finally arrived at the sole inference fairly to be drawn therefrom, namely, that heat and light, as also heat, electricity, and magnetism, are only so many different conditions in which the one calorific element exists in nature, and manifests itself by its mutations in phenomena.

Dr. Joule described the experiments he had made many years ago on the thermal effects of the dilation of elastic fluids, which he considered fatal to the doctrine of the materiality of heat. He called attention to the experiments which Mr. Dyer had made twenty years ago, indicating the possibility of generating heat by the agitation of water. These experiments, he believed, would prove to be of great interest to the history of science, and trusted that the Author would be able to place them before the Society.

Quarterly Meeting, January 25th, 1859.

W. Fairbairn, F.R.S., &c., President, in the Chair.

Augustus de Morgan, V.P.R.A.S., &c., Professor of Matehmatics in University College, London, and Arthur Cayley, Esq., F.R.S., &c., were elected Honorary Members of the Society.

M. Auguste le Jolis was elected a Corresponding Member.

The following gentlemen were elected Ordinary Members of the Society :—Mr. Thomas Carrick, Mr. James G. Lynde, The Rev. W. N. Molesworth, M.A., Mr. Henry Wilde, Mr. Richard Eadson, Mr. Thomas Sowler, Mr. James Dorrington, Mr. Henry Alexander Hurst, Mr. John Slagg, jun., Mr. George Mosley, Mr. William J. Rideout, Mr. James Thompson, Mr. Thomas Brittain, Mr. John William Mc Clure, Mr. M. L. Tait, Mr. Edward Coward, and Mr. John Watson.

Mr. Joseph Baxendell, F.R.A.S., was elected a Member of the Council, in place of the late Rev. H. H. Jones.

The President congratulated the meeting on the prosperous condition of the Library, paying a high tribute to the zeal and industry of the Honorary Librarian, Mr. F. Ekman. The efforts which had been made to obtain an exchange of published transactions with learned Institutions, at home and abroad, had been attended with great success, so that at present the most important of the scientific periodicals were in the possession of the Society.

Ordinary Meeting, February 8th, 1859.

W. Fairbairn, F.R.S., &c., President, in the Chair.

Mr. E. W. Binney, F.R.S., &c., communicated a Notice of the Lias Deposits at Quarry Gill and other places near Carlisle.—On the western side of the Pennine chain, after passing the small isolated patch of lias at Audlem, in Cheshire, none of the secondary rocks, superior to the trias, have been met with in the counties of Lancaster and Cumberland, therefore the discovery of a tract of lias near Carlisle is of considerable interest.

For some years past Mr. R. C. Brockbank, of the firm of Messrs. Carr and Co., of Carlisle, has been diligently engaged in searching for coal, and has investigated the country around Carlisle with considerable care. His attention was chiefly directed to the district lying between Curthwaite, on the Carlisle and Maryport Railway and the Solway, especially about Aikton and Oughterby, points which Professor Sedgwick had thought likely places for boring for coal, and where that eminent geologist had been informed a coal of sixteen inches in thickness had been actually found.*

The first place where Mr. Brockbank found the blue metals, which had always been supposed to be coal measures, was in the brook course at Thornby. In examining them he found a shell resembling an ammonite, and some other fossils, which induced him to think that the beds might possibly be lias. On his sending the specimens to me, through Mr. Brockbank, engineer, of Manchester, I immediately pronounced them to be lias.

On the 13th of January last, being at Carlisle, Mr. Brockbank was so kind as to drive me over the district. We first went to Moorhouse, near which place we saw the till of a reddish colour, exposed above twelve feet in thickness, without its bottom having been reached. It is full of stones, mostly rounded, and consisting of Criffel granites, slates, and silurian rocks, but it is, nevertheless, used for brick making. In the neighbourhood of Moorhouse the land is of a cold, clayey nature, and covered with considerable beds of peat. On passing through Oughterby, Mr. Brockbank pointed out the place at Moor Dyke where a small seam of coal had been reported to have been formerly worked. We next went to Quarry Gill, to look at the so-called mountain limestone, which had been quarried many years ago, and which Mr. Brockbank thought might probably indicate the position of some of the lower coals. That gentleman had found the dark shales in Thornby-brook, and from their fossils suspected them to be lias, but he never imagined that the Quarry Gill stone was anything but mountain limestone, and he quoted Professor Sedgwick and other geologists in support of that opinion. On going into the field where the old quarry had been opened, I picked up a piece of limestone which was without doubt lias. The old quarry is now filled up, but dark lias shales are seen *in situ* in the ditch near the well, and in the well itself the limestone is seen. The well derives its water from a bore, which is at present about six feet deep, through the limestone. The walls of the well are constructed of lias limestone, and that rock is found lying on the surface of the field. Herewith are exhibited specimens full of *Gryphæa incurva*, *G. inflata*, and *G. depressa*, and an *Ostrea*, besides other shells.

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* See Professor Sedgwick's Paper on the basin of the Eden and the north-western coasts of Cumberland, Vol. IV., New Series, of the Transactions of the Geological Society of London, p. 393.

At Fisher's Gill farm a well was sunk through the lias shales into the limestone.

At Thornby-brook, south-east of Aikton, are seen the lias shales, first found by Mr. Brockbank. These are met with in the brook course, and are not exposed more than two feet in height, and for a distance of under one hundred yards, being covered up by reddish coloured till. In the shales are found two or three species of *ammonites* and several bivalve shells. Ironstone nodules, also containing bivalve shells, occur in the shales. The dip of the strata is difficult to determine, but at one point I made it to be to west south-west, at an angle of 23°.

Mr. Robinson, an intelligent well sinker, informed us that in the course of his searches for water, he had become well acquainted with the dark shales and limestone in which people had long been searching for coal. This valuable substance, he had often heard, had been found in the neighbourhood, but he had not seen it, and never expected to do so. At Wiggonby a bore-hole had been put down forty yards into the dark shales. At Bank House the same beds had been seen near to the surface. They had also been met with at Flatt and Nut Gill. At Oughterby Pastures they are to be seen in the water holes which have been dug in them. At Orton, Sir W. Briscoe bored in them. Mr. Robinson thought that they had also been met with both in Crofton and Aikton. Thus, from his statement, this lias deposit occupies a considerable district, extending under the rising ground lying between Crofton and Orton on the south, and the Solway on the north, comprising Aikton, Thornby, Wiggonby, Oughterby, and probably other places on the rising ground lying between the Maryport and Carlisle, and the Port Carlisle and Carlisle Railways. As the district is covered with a thick deposit of till, the boundaries of the lias will be difficult to trace with certainty; but it appears to lie on the water-stones and red marls of the Trias, seen in the river Eden, near Carlisle, and which appears to dip somewhat in the direction of the lias described in this communication.

It seems somewhat singular that a comparatively large extent of lias should have so long escaped observation, but it is no doubt owing to the district being so thickly enveloped with till, and affording so few natural sections.

Mr. **William Brockbank** exhibited some large specimens of Titanium, which have recently been found in considerable quantities, filling the crevices, and under the hearths of the fire-brick linings of the furnaces of the Hematite Iron Company, of Whitehaven.

In one instance it occurred in a large mass weighing nearly 4 cwt., under the furnace hearth, having found its way through the crevices between the fire-bricks.

Smaller masses, weighing from 50 or 60 lbs. to a few ounces, were found filling the hollows and crevices in the lining of the furnace, around that part which holds the molten metal.

The occurrence of Titanium in such large quantities is a new and interesting circumstance, previous instances being confined to a few furnaces in South Wales (where Hermatite Ore is used as a mixture), and to some in the Hartz mountains, in both of which cases the specimens found were comparatively small.

Small crystals of it have long been found in the slags of many iron works.

Should any commercial use be discovered for Titanium, it could be supplied in considerable quantities.

Mr. **Alfred Fryer** exhibited to the meeting some specimens of tea grown at the foot of the Himalaya mountains.

Among the London Tea Sales in August, 1858, the first parcel of a new description of tea was submitted for public competition, and excited some considerable attention on account of its being the produce of the district of Cachar, in British India. The entire of the import was twenty chests, and consisted of the four kinds denominated Congou, Souchongs (1st and 2nd class), Pekoe, and Flowery Pekoe. The quantity being so inconsiderable—the parcel being merely an experiment—the prices realised were not so extreme as might have been expected, considering the remarkable character of the tea. The Flowery Pekoe realized about 30 per cent. more than the choicest sample of Assam Flowery Pekoe, which, in its turn, commands usually from 10 to 20 per cent. more than the finest samples of Chinese Flowery Pekoe. The Souchongs, however, were intrinsically the most valuable tea, and realized rates about equivalent to the then ruling rates of Assam Souchong. The Congou, although unprepossessing in leaf, is excellent in quality. It realized the current rate of *Assam Congou.*

The samples now submitted for inspection consist of Souchongs (1st and 2nd class,) and also of Congou. As compared with tea grown in China, the Cachar teas are distinguished by the hue of the leaf, which is very dark brown with a *dead* effect, or what is technically named "bloom" by the tea tasters. They are almost devoid of scent, and are excessively crisp and hard—technically, "in very high condition." In all the foregoing particulars they closely resemble Assam teas, but in the feature in which Assam teas have outvied those of Chinese growth, and thus commanded a high position in the tea market, the Cachar teas unquestionably excel—viz., in extreme strength, flavour, and pungency. Assam tea might be described as twice as strong as China tea, but Cachar Souchong is really thrice as strong as China tea. The flavour of Assam and Cachar teas is most suitable for mixing with Chinese tea, to bring up the flavour, and enable the tea to "hold out well" or bear a second infusion.

The teas produced in Java, and largely consumed in Holland and Belgium, are similar to Cachar teas in appearance, possessing the "bloom" alluded to in the foregoing remarks, but *in quality* they are diametrically opposed, the Java Congous and Souchongs, although strong, being soft, "*treacle-y,*" and entirely wanting in pungency.

There can be no doubt that if Cachar tea can be produced in quantity, with the characteristics exhibited in the consignment sold last year, the price obtainable would compensate the grower, inasmuch as it would doubtless command a preference over the Assam Company's teas, which are bought up greedily by the tea trade for imparting pungency and flavour to other teas.

The Rev. W. **Gaskell** read an extract from a letter of the Rev. Thomas Belsham (dated Hackney, August 16th, 1805), containing an account of a visit which he had just paid to the Duke of Grafton, in which the following passage occurs, and Mr. Gaskell wished to know whether any Member of the Society could confirm the statement made in it.

"Admiral Cosby told me one circumstance which was curious. When he was Commander-in-Chief in the Mediterranean, during the last war, at the time that we were possession of Corsica, and when Sir Gilbert Elliot Governor-General of the island, General Paoli intro Bonaparte, then a young man, to the Governor and Admiral, as a friend of his who would be glad to be emp in the service of England; but these wise men, not having Lavater's skill in physiognomy, rejected the proposal, which obliged Bonaparte to offer his services to the French, and this was the rise of Bonaparte's fortune. I had often heard that Bonaparte had offered his services to the English and been rejected, but I hardly gave credit to it till I learned it from Admiral Cosby himself."

Mr. **Hopkins** and Mr. **Roberts** said that, in their boyhood, they had often heard a similar statement made, but were not aware on what authority it rested.

A paper was read by Mr. **John Atkinson**, "On the Erosion of the Plates of Locomotive Steam Boilers, and the mode of preventing it."

The Author attempted to account for the erosion of the plates which takes place near the smoke-box, or *forward* end in the interior of the boilers of locomotive engines.

At the meeting of the Society on the 11th of January last, the President drew the attention of members present to certain phenomena of this kind, stating that near the angle-iron adjoining the smoke-box, the body of a boiler is often found deeply grooved or channelled all round the lower part, from near the surface of the water on one side to the same height on the other,—thus causing a weakening of the plates in that part of the boiler, which results in its explosion, when in other parts it is very little worn. It was asserted that stationary boilers are not affected in this way.

The Author had only the facts to go upon that were adduced on the occasion just mentioned, his explanation might not therefore be so put as to meet all the varieties of cases that may have occurred. The explanation was not so much a hypothetical one, as an attempt to trace to their consequences certain physical forces which must be brought into [illegible] in the working of a locomotive boiler. These forces [illegible]) chemical, exhibited in the oxidation of the plates, which of course would, in a quiescent state of the boiler, act uniformly over the greater part of its surface; (2) mechanical, or rather, dynamical, arising from the momentum acquired by the water, when the train is proceeding at a high velocity, acting, when the train is stopped by the break, with great pressure on the forward or smoke-box end of the boiler. This dynamical force or pressure, it was argued, besides exerting a great strain on the forward end of the boiler, must urge the water into oscillatory currents in the neighbourhood of the smoke-box, and thus rub off the coating of oxide which had formed in any angular recesses where a current could act with greatest intensity. This rubbing or eroding process must be greatly increased if the water contains sediment of a gritty nature. It was thought that the cases of grooving in the fragments of boiler-plates, exhibited on the 11th of January, might be fairly accounted for by the causes here mentioned. Other cases, not being known, could not be discussed.

Assuming the foregoing explanation to be correct in principle, the mode of preventing the furrowing of the plates complained of, would consist of adopting a plan of construction in boilers which would enable them to present a uniform resistance to the powerful dynamical force exerted by the water on the stoppage of the train, and which would cause the sedimentary deposit, instead of being collected in angular spaces to act as a cutting tool, to be diffused over as large a surface as possible.

Mr. **Fothergill** believed that the corrosion was owing to defective construction of the boilers. The caulking hammer had been applied close to the part corroded. This would cause the effects of unequal expansions to be principally experienced there.

Mr. **M'Connel** observed that the erosion was not, as had been alleged, confined to locomotive boilers. He had observed similar phenomena in stationary ones as well.

Mr. **Binney** drew attention to the fact, that the corrosion was at the smoke-box end. He believed that it might be owing to a chemical action, similar to that which had been noted by Dr. Henry, near the leaky joint of a cast iron steam pipe surrounded with charcoal.

Ordinary Meeting, February 22nd, 1859.

Thomas Hopkins, Esq., Vice-President, in the Chair.

Mr. Baxendell directed the attention of the Meeting to the fact, that a fine group of spots is now visible on the surface of the sun. There are also many bright spots or *faculæ*, and the general mottling of the solar disc is unusually coarse. He stated that Mr. Carrington, who had carefully observed the solar spots since the beginning of 1854, had found that up to February, 1856, when the minimum of spot-frequency occurred, the spots were grouped in an equatorial zone, within the limits of 20° north and south latitude; but immediately after the epoch of minimum a change in the distribution of the spots took place, and they have since been arranged in two zones, one in each hemisphere, between the parallels of 20° and 40°. Mr. Carrington had also found that spots near the equator gave a shorter period of rotation of the sun than those at a greater distance. Mr. Baxendell stated that he had lately observed one large group in which he had counted 25 separate dark spots, and at the same time there were six other groups visible, each containing from 8 to 15 spots. He also stated that both the dark and bright spots, and even the general mottling of the sun's disc, could at the present time be easily observed with telescopes of very moderate power.

The Chairman thought it very desirable that photographers should endeavour to obtain good images of the sun, and that regular observations should be made by this means of the sun's surface.

Mr. Atkinson inquired whether the comet, visible last year, had been observed in the southern hemisphere. Mr. Baxendell stated in reply that it had been seen and well observed at the Cape of Good Hope, by Mr. Maclear, who considered that neither the comet of 1811, nor that of last year, were equal in brilliancy to that of 1843.

The **Chairman** considered that the establishment of astronomical observations, in localities enjoying a clearer atmosphere than ours, would be a very useful measure on the part of government, but Mr. **Binney** thought that individuals ought not to be deterred from observing by the obstacles presented by the murkiness of our atmosphere.

Mr. **Curtis** presented a statement of the fall of rain during the year 1858, as observed by his son in the neighbourhood of Manchester. It appeared that the amount of rain last year was 30.53 inches, whereas in 1857 it was 31.94, and the average for the last 64 years was 35.562. November was an unusually dry month, there having been only 1.39 inches, whereas the average for that month was 3.56 inches.

A paper was read by Mr. **Thomas Carrick**, "On some Indications of law in the Grouping of Unexplained Cosmical Phenomena."

The aim of the Author was to shew that if the rotation of the heavenly bodies is assumed—for the purpose of enquiry—to have inseparable relation to their orbit motions, the unexplained cosmical phenomena, when analysed with reference to rotation planes, as well as orbit planes, present marked evidence of systematic distribution, indicating the presence and action of causal law.

The planes of the solar equator, the sun's orbit in space, and the milky way are considered essential bases of such an analysis. In the absence of the sun's orbit plane the analysis is necessarily imperfect. The two known planes intersect each other at two points, nearly coinciding with 265° and 85° heliocentric longitude.

These intersections of the milky way and solar equator planes, are adopted as grouping points.

The ascending nodes of five planets, when taken on the solar equator, are concentrated within an arc of 8°, covering the grouping point at 265°; and two more lie at a short distance therefrom.

The mean ascending node of all planets, planetoids, and comets, with direct motion, is at or near this point at 265°, whilst the greater part of the comets, with retrograde motion, group on the opposite point at 85°. There is a mean tendency in orbit planes to cross the solar equator at 265°, and to lie within the lenticular zones between the solar equator and the nearest section of the milky way (an angle of about 70°).

Planetary orbits lie nearest the equator plane, and in other orbits the successive increase of mean orbit distance from the sun is accompanied with a like successive increase in inclination—or divergence from the solar equator plane—until the comets, which penetrate furthest into space, tend to lie in the plane of the milky way.

A line connecting the two grouping points at 265° and 85° is very nearly the mean direction of the major axes of orbits of all kinds, when projected upon the solar equator plane; and a considerable excess in the grouping of major axes is found within 15° on each side of that line, both in planetoids and comets.

The perihelion points of all major axes, except retrograde comets, are grouped in very marked preponderance on the point at 85°, whilst a similar excess of perihelia of retrograde comets is found on the opposite point at 265°.

If rotation is assumed to have a cosmical value, the action of the sun and planets on each other ought to be polar in character; and if so, the major axis of an elliptic orbit, and the axis of rotation of the planet, should tend to have a common determinate general direction in space. It appears that when the axis of rotation of each planet, and the major axis of its orbit are both projected perpendicularly upon the plane of the solar equator, there is a very remarkable tendency to absolute coincidence in several cases; and with only Uranus and Neptune—the planets with retrograde rotation—as decided exceptions.

The poles of all the planets are within 30° of the milky way. A great circle drawn through the position of the sun's poles and the points at 265° and 85° will pass through or near the poles of all the planets. The two most distant lie on the milky way.

In confirmation of the importance of cosmical rotation, are many well-known facts in which mathematically exact relations subsist between planetary rotation planes and satellite orbit planes.

In attempts to account for exceptional phenomena, cosmical rotation has frequently been assumed as the basis of polar relations between the sun and comets.

In the sciences of the imponderable elements are known perturbations whose periodic time coincides with changing polar aspects of the sun and earth:—and atomic rotation and consequent polar action lie at the root of the best accredited theories of science.

Until the importance of cosmical rotation is duly recognised it will be found impossible to co-relate physical astronomy either with the sciences of the imponderable elements on the one hand, or the residual phenomena of the universe on the other.

Centuries must elapse before the plane of the orbit of the solar system in space can be determined by direct observation. A method was indicated by which the intersection of that plane on the solar equator might possibly be determined through the universe problem of perturbations.

It is based upon known mathematical relations existing in the system of Jupiter.

Ordinary Meeting, March 8th, 1859.

W. **Fairbairn**, F.R.S., &c., President, in the Chair.

A conversation having taken place respecting Sir W. Armstrong's new gun, Mr. **Roberts** stated that he had, very many years ago, constructed a rifled cannon for the purpose of firing elongated shot coated with lead. Dr. **Smith** considered that the great merit of the new gun consisted in the manner in which the internal tube of steel was enveloped with wrought iron. The difficult problem of forming a perfect compound structure had received solution in the hands of Sir W. Armstrong, while others had failed.

Dr. **Joule** read an extract from a letter he had some time ago received from Professor W. Thomson.—"I have had an apparatus for Atmospheric Electricity put up on the roof of my lecture room, and got a good trial of it yesterday, which proved most satisfactory. It consists of a hollow conductor supported by a glass rod attached to its own roof, with an internal atmosphere kept dry by sulphuric acid: the lower end of the glass rod is attached to the top of an iron bar, by which the hollow conductor is held about two feet above the inclined roof of the building. A can, open at the top, slides up and down on the iron bar which passes through a hole in the centre of its bottom, and, being supported by a tube with pulleys, &c. below, can easily be raised or lowered at pleasure. A wire attached to the insulated conductor passes through a wide hole in the bottom of the can, and is held by a suitable insulated support inside the building, so that it may be led away to an electrometer below. To make an observation, the wire is connected with the earth, while the can is up, and envelopes the conductor—its position when the instrument is not in use. The earth connection is then broken, and the can is drawn down about eighteen inches. Immediately the electrometer shows a large effect (from five to fifteen degrees on my divided ring electrometer, in the state it chanced to be in, requiring more than one hundred degrees of torsion to bring it back to zero, in the few observations I made). When the surface of the earth is, as usual when the sky is cloudless, negative, the electrometer shows positive electricity. But when a negative cloud (natural, or of smoke) passes over, the indication is negative. The insulation is so good that the changes may be observed for a quarter of an hour or more, and when the can is put up the electrometer comes sensibly to zero again, showing scarcely any sensible change when the earth connection is made, before making a new start."

Dr. JOULE stated that he had recently witnessed experiments with Professor Thomson's new Atmospheric Electrometer, the merit of which consisted in its extreme sensitiveness, and the facility with which accurate observations could be made with it.

A Paper was read by Mr. RICHARD ROBERTS, M. Inst. C.E., entitled, "Proposed Improvements in Pharology."

After adverting to the remarkable fact that the great majority of wrecks and collisions occurred in the immediate vicinity of the beacons intended to guard against them, Mr. Roberts mentioned that amongst the numerous schemes propounded for the improvement of our present system of pharology, that of Mr. Herbert, of the Admiralty, who proposed to moor a series of floating lighthouses of great power of illumination, in a direct line up the centre of the English and other channels, appeared the most worthy of attention. He (Mr. Roberts) perfectly agreed with this suggestion, to which his attention had been first called by Mr. Murphy's paper, read in section G of the British Association, recently held at Leeds, when it at once occurred to him that the principle of gyration might be advantageously employed to neutralize the action which the wind and waves exert upon floating light ships.

After briefly describing the principal features of the catoptric and dioptric systems, Mr. Roberts stated that the latter was inapplicable to floating beacons, owing to their great oscillation, and that they were therefore still furnished with 12in. reflectors, whose power was comparatively small. He felt convinced, however, that the more fully the system of Mons. Fresnel became understood, the more certainly would it be preferred to the catoptric system, over which it possessed, among other advantages, that of producing about four times the amount of light as the effect of the combustion of the same quantity of oil.

It was, however, essential to the adoption of this system, that the light apparatus be kept upright and free from oscillation, to attain which desideratum Mr. Roberts proposed entirely to change the form of the vessel, making that portion of it which was immersed hemispherical, and that which was above water the frustrum of an inverted cone, as he thought that this form would present less resistance to the wind and waves, where these were expected to act from every point. In certain situations, however, a double pointed vessel might be advantageously used.

In the centre of this float Mr. Roberts proposed to build a tower (whose lower end should project through the bottom of the float to serve as a keel) carrying a lantern as in shore lighthouses, and containing the necessary accommodation for the light keepers, &c., and within this lantern he proposed to place a dioptric apparatus of the second power, whose light being placed forty-five feet above the water line, might be seen at a distance of nine miles. Immediately below the light apparatus he would place a fly wheel suitably mounted on gimbals, and driven through the medium of certain wheels and shafts by a small engine, which with its boilers, would be placed on the third deck of the float, or this wheel might be caused to revolve at its proper speed by two relays, each of three men. The engines and steam might be used for a variety of purposes, as to sound bells or whistles, hoist coals aboard, prevent the adhesion of snow to the lantern, &c.

Mr. Roberts proposed to moor the float by three anchors, to each of which he would attach two heavy cables, passing through hawse pipes 120° from each other; the tension on these he would regulate by a suitable windlass, and he fully believed that by this system of mooring the float (which together with the tower he would construct of iron), and by causing the dioptric apparatus to rotate (about one hundred times per minute), the desired object would be attained.

Ordinary Meeting, March 22nd, 1859.

W. Fairbairn, F. R. S., &c., President, in the Chair.

The **President** exhibited a specimen of Mr. Allen's submarine electric cable, which consists of a central copper wire strengthened by an envelope of fine steel wires, the whole being coated with two or three layers of gutta percha. In the conversation which ensued, an opinion was expressed that this form of cable would be liable to kink, particularly if laid in heavy weather. It was suggested that a better insulating medium than gutta percha might be discovered.

Mr. **Ransome** stated that he had frequently found that gutta percha became so rotten in the course of two or three years that it could be crumbled away between the fingers. It could, however, be restored to its original condition by immersing it in hot water.

Professor **Calvert** remarked that immersion in water did not always preserve the qualities of gutta percha. A specimen which he had kept immersed in distilled water had ultimately become completely rotten. The gutta percha of commerce was frequently much adulterated.

Mr. **Binney** made the following statement. "In the public prints, frequent allusions are made to micro-photography. In the *Manchester Guardian* of the 11th March instant, is the following paragraph:—'Photographic curiosities.—M. Amadio of Throgmorton-street, whose portrait of Charles Dickens no larger than a pin's point was lately noticed, has produced by photography a view of Westminster Bridge, the Houses of Parliament, and Westminster Abbey, within a space not larger than the eye of a worsted needle. The same gentleman has published a portrait of a youth which is only just larger than a needle's point, but, when magnified is as perfect as any conceivable likeness.' No doubt most of the members of this society have seen the beautiful specimens of micro-photographic art produced by one of our fellow-members, Mr. J. B. Dancer, F.R.A.S., during the last five years. So early as the year 1840 Mr. Dancer began his investigations on the subject, and soon produced satisfactory results on silver plates. In May, 1853, when Dr. Joule, F.R.S., and some other friends erected a tablet to the memory of our late distinguished member, Mr. Wm. Sturgeon, the electrician, Mr. Dancer was so kind as to present me with a photograph of the tablet not larger than a pin's head. His discovery was not allowed to rest, for hundreds of his beautiful specimens were sent all over the world. Within the last year or two, several parties have coolly claimed Mr. Dancer's discovery, and when it is represented in a local print as something wonderful in M. Amadio having produced what Mr. Dancer did six years ago, it is only due to our fellow-member and townsman to set the public right as to who was the real discoverer of micro-photography."

A Paper was read by the Rev. T. P. KIRKMAN, M.A., F.R.S., "On the *j*-nodal *k*-partitions of the *r*-gon." The problem of the partitions of the *r*-gon which I have before investigated (Manchester Memoirs, 1858, and Philosophical Transactions, 1857), treats of the number of ways in which *k* diagonals can be drawn, none crossing another, each through two angles of the *r*-gon. The complete problem, which might be called *the reticulations of the r-gon*, considers in how many ways the area of the polygon can be divided into *k* smaller polygons, none covering another, whose sum shall be the entire *r*-gon, by lines passing through any of the *r*-angles, or through any of *j* points taken within the *r*-gon. The *j* internal points may be called the nodes of the partition, and it is evident that at least three of the drawn lines will meet in every node. When $j=o$, the problem is merely that case of these partitions which I have already completely considered.

This question of reticulations is closely connected with the theory of the polyedra, and is not a whit less complex and difficult.

I am in possession of a complete solution of this problem of reticulations, of which, however, I shall for a season defer the publication. My object in this Paper is chiefly to place on record some of my numerical results. And I think it highly probable that any mathematician, who may take the trouble to verify them, will completely satisfy himself as to how far I am in possession of the entire theory of these reticulations.

It is worth while to remark, that investigations of this nature have recently acquired a new and important interest, from the fact, that the Imperial Institute of France has chosen the subject of the polyedra for its grand Mathematical Prize (the gold medal of 3,000 francs) for the year 1861. The proposal runs thus—"Perfectionner en quelque point important la Théorie des polyèdres." The memoirs are to be sent in before July 1, 1861, written either in Latin or in French.

Among the propositions that I have to communicate, are the following:

1. The number of 7-reticulations of the pentagon is 7774, of which 413 are symmetrical.
2. Of these, the 4-nodal 7-partitions are 62 symmetrical, and 1006 unsymmetrical.
3. The 5-nodal 7-partitions are 85 symmetrical, and 2000 unsymmetrical.
4. The 6-nodal 7-partitions are 99 symmetrical, and 2282 unsymmetrical.
5. The 7-nodal 7-partitions are 69 symmetrical, and 1340 unsymmetrical.

The remainder have more than seven nodes, or less than four.

In this enumeration no figure is counted which is either the repetition or the reflected image of any other.

The method by which these results are obtained is perfectly general, is in no way tentative, and involves no reference to figures.

Although I have given formulæ whereby the k-partitions of the r-gon, $(j=o)$ can be found for all values of r and k, by an inductive method, much remains to be accomplished before the direct expression of them in terms of r and k is obtained.

I have already investigated such general expressions for the $(r-2)$-partitions of the r-gon, *i.e.* the triangular partitions, made by drawing $r-3$ diagonals, in the last volume of the Manchester Memoirs.

About the simplest case that can occur, when there are fewer than $r-3$ diagonals, *i.e.* when the partition is not triangular, is that in which the r-gon is divided into $k+2$ triangles and quadrilaterals, the number of marginal faces being two only, both triangles, and every angle but two being occupied by a diagonal.

If this figure consists of two marginal triangles, separated by k quadrilaterals, all the diagonals being parallels, there is only one way of drawing it.

If the figure has non-marginal triangles, that is, if the number $k+2$ of the diagonals is greater than $\frac{1}{2}r-1$, it will, as in every other case, either be symmetrical or asymmetrical. If there is a symmetry of reversion, it will have a diametral axis of reversion, either drawn through two angles, or drawable through one angle and the middle of a side, or else drawable through no angle and the mid-points of two opposite sides. In the first of these three cases, the figure is said to have a *diagonal* axis, in the second a *monogonal* axis, and in the third, an *agonal* axis of reversion. A section along this axis of reversion divides the figure into halves, of which one is the reflected image of the other.

If the symmetry is not one of reversion, it is one of repetition; that is, there is an irreversible sequence of configuration read twice in the circuit of the r-gon.

Let $k+2$ be the number of the diagonals; and let

$$R^2(r, k+2),\ R^{ag}(r, k+2),\ R^{di}(r, k+2),\ R^{mo}(r, k+2)\ I^2(r, k+2),$$
$$I(r, k+2),$$

be the numbers of the five classes of $(k+3)$-partitioned r-gons, having only two marginal faces, both triangles, having every other face either a triangle or a quadrilateral, and having every angle except two, viz., one in each marginal triangle, occupied by a diagonal. The first class has two axes of reversion, and has no triangles except the marginals. The next three have one axis of reversion, agonal, diagonal, or monogonal. The fourth has a repeated irreversible sequence; the fifth is simply irreversible, that is, has its upper surface different from its lower, and has no symmetry of repetition.

The expression of these numbers, in which no figure is enumerated which is the repetition or the reflected image of another, is the following:

$$R^2(r, k+2)=0^{(r-6-2k)^2}+0^{(r-4-2k)^2};$$

$$R^{ag}(r, k+2)=\Sigma_y\frac{1}{1+0^{\frac{1}{4}(r-6)-y}}\left\{\frac{(\frac{1}{2}k)^{y|-1}}{1^{y|1}}\cdot\frac{y^{\frac{1}{2}(r-6-k)|-1}}{1^{\frac{1}{2}(r-6-k)|1}}\right\},$$

where r and k are even; $y=$ or 7 0; y not $7\frac{1}{4}(r-6)$;

$$R^{di}(r, k+2)=\Sigma_y\frac{1}{1+0^{\frac{1}{4}(r-4)-y}}\left\{\frac{\left(\frac{1}{2}(k+1)\right)^{y|-1}}{1^{y|1}}\cdot\frac{y^{\frac{1}{2}(r-k-5)|-1}}{1^{\frac{1}{2}(r-k-5)|1}}\right\}$$

where r is even and k is odd; $y=$ or 7 0; y not $7\frac{1}{4}(r-4)$;

$$R^{mo}(r, k+2)=\Sigma_y\frac{(\frac{1}{2}k)^{y|-1}}{1^{y|1}}\cdot\frac{y^{\frac{1}{2}(r-k-5)|-1}}{1^{\frac{1}{2}(r-k-5)|1}},$$

where k is even and r is odd; $y=$ or 7 0, not $7\frac{1}{2}(r-5)$;

$$I^2(r, k+2)=R^{ag}(r, k+2)+R^{di}(r, k+2);$$

$$I(r, k+2)=\tfrac{1}{2}\left[\Sigma_y\frac{1}{1+0^{\frac{1}{2}(r-4)-y}}\left\{\frac{(k+1)^{y|-1}}{1^{y|1}}\cdot\frac{y^{r-k-5|-1}}{1^{r-k-5|1}}\right\}-\right.$$
$$\left.\left(R^2+R^{ag}+R^{di}+R^{mo}+I^2\right)(r, k+2)\right],\ y=\text{ or } 7\ 0,\text{ not } 7\ \tfrac{1}{2}(r-4).$$

Here $a^{b|+1}$ stands for the product $a(a+1)(a+2)\ldots$ to factors b, and $a^{b|-1}$ for $a(a-1)(a-2)\ldots$ to b factors.

I have to correct two oversights in the 16th and 22nd articles of my Paper, "On the triedral partitions of the x-ace" (Manchester Memoirs, 1858). In the 16th article, not only doubly irreversibles, but also the doubly reversibles, of article 15, are constructed, so that these ought to be subtracted before dividing by two. In the 22nd article the triply reversibles of article 20, as well as triply irreversibles, are constructed; it is therefore necessary to subtract the triply reversibles and then to divide by two, for the reason given in the 16th article.

The Paper, of which this is an abstract, will contain the corrected formulæ.

From the partitions of the r-gon having two triangles only for its marginal faces which are above considered, it is easy to obtain the expression of the partitions of the $(r+x)$-gon, which have any two marginal faces, and have any number of angles unoccupied by diagonals. For this deduction formulæ are given in this Paper.

Dr. JOULE having taken the Chair, a Paper was read by the President, W. FAIRBAIRN, F.R.S., &c., entitled "An experimental inquiry into the effect of severe pressure upon the properties of Gunpowder." During the late war, the Author received from the Government authorities at Woolwich different samples of Waltham Abbey gunpowder, for the purpose of submitting them to severe compression, in order to ascertain the effect of close contact between the particles upon its explosive properties. At the Government works there is no machinery of sufficient strength to give a pressure of more than 5,000lbs. to 6,000lbs. per square inch, and as it was considered advisable to test the quality of the powder under the influence of greatly increased pressure, the Author was requested to compress it, in an apparatus of his own, calculated to effect its condensation under a force of more than 60,000lbs. per square inch. By carrying the pressure in this way far beyond the ordinary limits, it was expected that the precise influence of compression on the properties of the powder would be more clearly and accurately exhibited.

The samples of powder were placed in a wrought iron box, and compressed by a lever acting upon them by a solid piston with a force varying from 38,000lbs. to 67,000lbs. per square inch in the different specimens. When taken from the apparatus, the powder was found to have been consolidated into cylinders of 1¼ inches in diameter with smooth polished surfaces, every trace of its granular character having disappeared.

From the Report of Mr. Abel, the Chemist of the War Department, we learn that the specific gravity of the specimens was increased by the pressure, but not to so great an extent as might have been expected.

The specimens having been granulated were then burned, and it was found, on comparing the results with those of similar experiments on ordinary press-cake, that the amount of residue left by the compressed powders, after ignition, was greater in proportion as the pressure was increased. This increase of residue is probably to be attributed to the more gradual combustion and the diminished intensity of heat generated by compressed powder.

Experiments were then instituted to determine the amount of charcoal left unconsumed in the residue. They showed conclusively that the condensation of the powder had caused a more perfect chemical action in combustion, as the percentage of carbon was considerably diminished in the compressed powders. Nitric acid was very carefully searched for in the residues of the compressed powders, but none could be detected, although in ordinary gunpowder a portion of the acid of the saltpetre always escapes decomposition.

An important objection to the application of increased pressure in the manufacture of gunpowder, notwithstanding the more intimate mechanical mixture of its constituents, is, that the quantity of the residue left after combustion is increased, and a larger proportion of powder escapes ignition altogether when a charge is fired from a gun. If, however, larger quantities were submitted to compression, it is probable that the closer contact of the particles might be found to act beneficially, and a powder be produced of an improved and stronger quality, resulting from a judicious application of increased pressure and a more perfect system of granulation.

Dr. Roscoe expressed his opinion that we as yet know very little about the chemistry of gunpowder, and drew the attention of the Society to the interesting and important "Memoirs on the Analysis of the Products and Combustion of Gunpowder," lately published by Professor Bunsen. He found that the decomposition which occurs in an explosion, is by no means as simple as was formerly supposed. Besides the usual products of carbonic acid, carbonic oxide, nitrogen, and sulphide of potassium, Bunsen showed the presence of hydrogen, oxides of nitrogen, cyanide of potassium, sulpho-cyanide of potassium, sulphate and carbonate of potash, and various other salts, the relative quantities of which were all determined.

Several of the Members suggested that the experiments, which were highly important, should be repeated, Government granting the funds which were requisite to prepare the compressed gunpowder in the same state of granulation and as it is in the samples with which it is to be compared.

Ordinary Meeting, April 5th, 1859.

Dr. J. P. Joule, Vice-President, in the Chair.

Mr. Curtis and Mr. Henry Bowman were appointed Auditors of the Society's accounts for the year.

The Chairman exhibited several slips of paper, having messages inscribed upon them by Professor Thomson's new electric telegraph apparatus. In these specimens the marking consisted of a succession of minute perforations, produced by sparks from an inductive coil apparatus while the paper was gradually drawn through the machine. The sparks are directed to the paper by a fine platina wire affixed perpendicularly to a light arm attached to a small magnetic needle suspended within a coil of wire. The directive tendency of the needle is made very great by means of adjacent steel magnets. So long as either no current or an uniform flow passes through the coil, the perforations go on in a straight line. To produce signals, temporary electric currents of longer or shorter duration are transmitted. The magnetic needle carrying the platina wire is thus deflected, causing the line of perforations to assume the shape of a succession of letters V of various width and at various distances asunder, and in this way letters and words are indicated by the use of a given code of signals. The chief advantage of this system of telegraphic recording is that it gives clear legible signals when a "relay" is entirely thrown out of action by inductive embarrassment. It has also the advantage of showing clearly signals superimposed on earth currents. The signal, superimposed either on the large *swell* or *wave*, of induction or of an earth current, is like a ripple seen distinctly on a large wave. The Chairman stated that Professor Thomson had recently discovered the means of giving a surer direction to the electric sparks, and of producing a very considerable increase in the size of the perforations produced by them. He also remarked that the system above described was similar in principle to that employed by Professor Thomson in transmitting the whole of the messages which had crossed the Atlantic from either side. To him, therefore, the merit of having given a temporary success to the Atlantic telegraph exclusively belongs.

Mr. T. T. Wilkinson, F.R.A.S., called the attention of the meeting to the existence of a very valuable manuscript in the Chetham Library, which he had been permitted to copy. It contains nearly forty letters on various mathematical subjects, written between "April 29th, 1774," and "September 27th, 1777," by the Rev. John Lawson, B.D., and the Rev. Charles Wildbore, M.A., editor of the *Gentleman's Diary*. Several of the earlier letters contain a Philological and Mathematical discussion on Porisms, as known to Fermat, Halley, and others. In the third and fourth letters, Mr. Jeremiah Ainsworth, of Manchester, is alluded to as an able Geometer. The fifteenth letter contains a long and interesting discussion on Porisms, which appears to have been intended for the perusal of Earl Stanhope, since he says that "perhaps it may not displease his *(Dr. Simson's)* noble editor to find another person's opinion coinciding with the Doctor's." This dissertation was written before the publication of Dr. Simson's *Opera Posthuma*, and occupies ten closely-written pages of manuscript. The seventeenth letter announces the publication of Mr. Lawson's "*Geometrical Analysis of the Ancients;*" and Mr. Ainsworth is afterwards stated to have solved all the geometrical questions appended to that able work in a "very ingenious manner." Most of the remaining letters are occupied with the discussion of various problems which then attracted the attention of mathematicians. The anecdotes respecting the contemporaries of the writers are not only amusing, but instructive; and the historical bearings of the whole series upon the Mathematical Literature of the period are neither few nor unimportant. Towards the close of the correspondence, the writings of Dr. Henry Clarke, another Manchester mathematician, are mentioned both for approbation and correction. Mr. Wilkinson considered that the publication of the letters would not be without its advantages, and he thought that the Chetham Society would do well to include the collection in their valuable series.

A Paper was read by the Rev. ROBERT HARLEY, F.R.A.S., entitled, "The Method of Symmetric Products, and its Application to the Finite Algebraic Solution of Equations."

This Paper is divided into three sections. The first contains a systematic exposition of Mr. Cockle's Method of Symmetric Products, with illustrations of its power and efficiency when applied to the lower equations. In the second, the Author discusses the resolvent product (θ) for quintics, and defines a new cyclical symbol (Σ'). He shows that θ has six, and only six, values, and that when any one of these values vanishes, the equation of the fifth degree admits of finite algebraic solution: its roots are actually exhibited. Mr. Cockle's new solvible form is verified, and shown to include, as particular cases, the quadrinomials of De Moivre and Euler. The third section contains a direct calculation of the equation in θ. The cöefficients are followed, one by one; the calculation being carried on by means of the cyclical symbol Σ', which is shown to possess peculiar working properties. The resulting sextic is found to coincide with Mr. Cockle's equation, obtained by a wholly different method, which was laid before the Society a few months ago in his "Researches in the Higher Algebra." The Author notices the steadiness with which the Method of Symmetric Products mounts up to the higher equations, and concludes by expressing his belief that the equation in θ—the verification of which has involved prodigious labour—will be found to be a canonical equation in the theory of quintics.

A paper was also read by the Rev. W. N. MOLESWORTH, M.A., "On Comparative Sociology, or the Application of the Comparative Method to the Investigation of Social Laws." The Author, after adverting to the present state of social science, and accounting for its backwardness by the difficulty and complexity of its phenomena, as well as the insufficient scientific preparation of many of its students, proceeded to propose the institution of a new science under the title of Comparative Sociology, in which the comparative method, of which comparative anatomy affords the best exemplification, would be applied to the investigation of social phenomena. For the purposes of this science he proposed that all natural human societies should be comprehended under five great classes. 1. The wedded pair. 2. The family. 3. The community (whether village, town, or city). 4. The tribe or nation. 5. The world or mankind.

He pointed out that it would be necessary, not only to ascend and descend this scale, in order to the discovery of social laws and the due appreciation of social phenomena, but also to carefully trace and analize the various stages through which each of these five classes of phenomena passes from its origin, so that all history must contribute the materials from which this science must be formed.

As exemplifications of the practical application of the proposed science, the Author referred to the subjects of education, jurisprudence, and to the study of the laws of property and the laws of exchange, which constitute the only scientific portion of the various researches which are comprised under the denomination of political economy.

The object of the Paper was stated to be—to explain the general character of the proposed science as well as its vast extent requiring the co-operation of many labourers in its various fields of observation and enquiry, and to shew that its students may fairly hope to reap the reward of their labours in the gradual discovery of natural social laws which will lead to better order, safer progress, sounder social organization, and more effective political action, as well as to the removal of many subjects of fierce controversy between individuals, communities, and nations, which arise from our present ignorance of the natural laws of society, and will only cease when it is remedied.

Annual Meeting, April 19th, 1859.

W. Fairbairn, F.R.S. President, in the Chair.

The following gentlemen were elected members of the Society:—As Honorary Members: W. J. Macquorn Rankine, LL.D., F.R.S., &c.; Baron Carl T. von Reichenbach. As Ordinary Members: Thomas Heelis, Thomas Reade Wilkinson, Arthur Ransome, B.A., M.B., M.R.C.S.

The following Report was then read by Dr. Schunck, one of the Secretaries:—

In presenting their Annual Report, the Council beg leave to express their conviction, that at no period of its existence has the Society been in a more flourishing condition. The increase in the number of members, the interest taken in the meetings, as manifested by the numerous attendance of members, the more than average quality of the communications read before the Society, the zeal manifested by the great majority of the members in promoting the interests of the Society, the rapid increase in the number of books in the library—due in great measure to the perseverance and enthusiasm of our present librarian—are circumstances which justify the Council in arriving at this conclusion. It is true that the great minds, whose genius was the pride of our Society during the early period of its history, and whose labours as recorded in the Memoirs form the foundation on which our renown as a Society rests, are no longer amongst us, and their loss is one which no industry and no zeal can ever supply. Nevertheless our reputation in the scientific world is still very high, and it should be our earnest endeavour to do all in our power to sustain this reputation; and above all things not to allow the character of our Memoirs, which forms the very basis on which our reputation is founded, to sink to anything like mediocrity.

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At the last Annual Meeting, the Society consisted of one hundred and eighty-one ordinary members. Since then one has resigned and three have died, whilst twenty-one new members have been elected, making the number at present on the list one hundred and ninety-eight.

Among the deceased members, the most prominent was the Rev. Henry Halford Jones. Mr. Jones was elected a member of this Society in April, 1846, and continued a member until March, 1855, when he resigned. He was, however, re-elected in January, 1856, and continued a member to the time of his death. Mr. Jones served on the Council from April, 1849, to April, 1854, and again from April, 1856, to the period of his death. During four sessions, commencing in April, 1851, he acted as one of the secretaries of the Society. Mr. Jones at all times took a most lively interest in the affairs of the Society, both as a member of the Council and of the Society at large. The subject to which he chiefly devoted his attention was Astronomy. His communications to the Society were not numerous, and only a portion of them were printed in the Memoirs. Their titles are as follows:—

(*a*) "Brief remarks on the supposed discovery of a central sun."

(*b*) "On the lengths of degrees, and the corresponding latitude of Manchester."

(*c*) "A biographical notice of Peter Clare, F.R.A.S."

(*d*) "An account of his compensation pendulum."

(*e*) "An exemplification of a simple mode of calculating the distance of a fixed star whose parallax has been ascertained."

(*f*) "Remarks on the occultation of Jupiter and his satellites by the moon."

(*a*) Read Feb. 23, 1847.
(*b*) Read Dec. 24, 1850.
(*c*) Vol. X., P. 203.
(*d*) Read Oct. 4, 1853.
(*e*) Read Dec. 30, 1856.
(*f*) Vol. XIV., P. 151.

Mr. Jones's death occurred very suddenly on the 21st of December last, and was so unexpected that at the Meeting of the Society, which took place in the succeeding week, a communication by a non-member, on a new invention for propelling ships, was to have been made through him and explained by him to the Society.

Mr. Caw, one of the other deceased members, acted as Librarian to the Society during three years, viz., from 1853 to 1856.

Among the Honorary Members of the Society one death has taken place during the past year, viz., that of Dean Peacock, the eminent Mathematician.

The Titles of the Papers read during the Session 1858—9, are as follows :—

October 5*th*, 1858.—" Researches in the Higher Algebra," by James Cockle, M.A., F.R.A.S.

November 2*nd*, 1858.—" Note on Dalton's Determination of the Expansion of Air by Heat," by J. P. Joule, LL.D., F.R.S., &c.

November 16*th*, 1858.—" Notice of some Experimental Apparatus for determining the Density of Steam at all Temperatures," by W. Fairbairn, F.R.S., &c., *President of the Society*.

"An Account of the Fall of Rain at Manchester, from the year 1786 to 1857, inclusive," by Mr. John Curtis.

November 30*th*, 1858.—" On the Utilization of the Sewage of London and other large Towns," by J. P. Joule, LL.D., F.R.S., &c.

December 14*th*, 1858.—"On Weather and the Operating Causes of its Changes," by Mr. Thomas Hopkins.

December 28*th*, 1858.—" On the Practicability of Counteracting a Portion of the Resistance at the Head of a Ship by Employing a Revolving Bow to work a Stern Propeller," by Mr. Thomas Morris.

January 11*th*, 1859.—" On Imponderable Matter Considered as an *Element*," by Mr. J. C. Dyer.

February 8*th*, 1859.—"On the Erosion of the Plates of Locomotive Steam Boilers, and the Mode of Preventing it," by Mr. John Atkinson.

February 22*nd*, 1859.—"On some Indications of Law in the Grouping of Unexplained Cosmical Phenomena," by Mr. Thomas Carrick.

March 8*th*, 1859.—"On Proposed Improvements in Pharology," by Richard Roberts, M. Inst. C.E.

March 22*nd*, 1859.—"On the *j*-nodal *k*-partitions of the *r*-gon," by the Rev. T. P. Kirkman, M.A., F.R.S.

"An Experimental Inquiry into the Effects of Severe Pressure upon the properties of Gunpowder," by W. Fairbairn, F.R.S., &c., President of the Society.

April 5*th*, 1859.—"On the Method of Symmetric Products and its Application to the Finite Algebraical Solution of Equations," by the Rev. Robert Harley, F.R.A.S.

"On Comparative Sociology, or the Application of the Comparative Method to the Investigation of Social Laws," by the Rev. W. N. Molesworth, M.A.

Of these, a number have already been printed. Others are still under the consideration of the Council, and it is expected that the second part of the fifteenth volume of the Society's Memoirs, of which the first part was published in November last, will be ready for publication soon after the conclusion of the present session.

The publication of the Proceedings of the Society, which has taken place regularly soon after each meeting, has been conducted in such a manner, the Council believe, as to give satisfaction to the members. By this means such members as do not attend the meetings, as well as the scientific world at large, are able to ascertain what occurs at each meeting; and, what is quite as important, the dissensions which so long agitated the Society in regard to the more speedy publication of papers, have, by adopting the plan now in force, it is hoped, been finally closed.

One of the most interesting events which have occurred within the Society during the past year, has been the formation of a Microscopical Section among the members. As this section is still quite in its infancy, it would be useless to speculate on its future career. The Council would merely remind the members of this section that as an integral portion of the Society, it is in their power, by their proceedings, either to increase or diminish the scientific reputation of the whole body.

At the conclusion of last session, a committee was appointed to attend to the repairing and painting of the Society's building, the ventilation of the meeting room, and other matters requiring immediate attention. The committee lost no time in entering on their task, which was completed before the commencement of this session. A great portion of the interior has been re-painted and re-papered, new gas lights have been fixed, and a plan of ventilating the meeting room has been brought into operation. The members have had an opportunity during the course of this session, of judging of these alterations and repairs; and as no complaints have been heard in reference to them, the Council conclude that they have been effected in such a manner as to give general satisfaction. The cost has amounted to nearly £100.

The financial condition of the Society will be seen from the Treasurer's balance sheet.

HENRY MERE ORMEROD, TREASURER, IN ACCOUNT WITH THE LITERARY AND PHILOSOPHICAL SOCIETY OF MANCHESTER, FROM 25TH MARCH, 1858, TO 12TH APRIL, 1859.

Dr | **Cr.**

Dr.	£.	s.	d.	£.	s.	d.
To Balance in Bank of Sir B. Heywood and Co., March 25, 1858	176	12	3			
,, Ditto in the hands of the Treasurer	20	17	5½	197	9	8½
,, Arrears of Subscriptions 1886-7, No. 2	2	10	0			
,, Ditto ditto 1857-8, 15	18	15	0			
,, Subscriptions 1858-9, 166	207	10	0			
,, Ditto 1859-60, 2	2	10	0			
,, Half Subscriptions 1858, 1	0	12	6			
,, Ditto 1859, 17	10	12	6	242	10	0
,, Admission Fees				44	2	0
,, Volume XV. sold	4	13	9			
,, Other Memoirs sold	1	10	9			
,, Interest allowed by Bankers	2	15	11			
,, Discount, &c. by Tradesmen	0	15	0			
,, Repayment by Photographic Society	4	0	0	13	15	5
,, Donations Library Special Fund				20	7	0
,, Donation from Photographic Society				10	0	0
Arrears outstanding 1857-8, No. 4	5	0	0			
Ditto 1858-9, 17	21	5	0			
	£26	5	0			
				£528	4	1½
To Balance brought down, General Account	94	9	2½			
Library Special Fund	45	1	6			

Cr.	£.	s.	d.	£.	s.	d.
By Chief Rent				12	12	4½
,, Fire Insurance				4	17	6
,, Water Rent				0	7	0
,, Property Tax				3	10	10
,, Printing and Stationery				14	10	2
,, Proceedings				13	7	0
,, Memoirs				67	8	0
,, Library				4	1	1
,, Ditto Special Fund				23	13	6
,, Stamps				0	5	6
,, Postage and Parcels				17	19	11
,, Coals				6	19	6
,, Candles				2	2	0
,, Gas				4	8	6
,, Tea and Coffee				17	1	11½
,, Keeper's Salary				60	0	0
,, Cleaning				1	5	9
,, Furniture				0	11	8
,, Repairs				2	10	2
,, General Repairs, Painting, &c.				99	6	0
,, Watt Fund, expended on Cases, &c.				30	0	0
,, Photographic Society, attendance, &c.	£3	10	0			
,, Less included in other items	1	15	0	1	15	0
1858-9. Total Disbursements, as by Cheque and Voucher Book				388	13	5
1859, April 12.—Balance in Bank of Sir B. Heywood, and Co., £114 17s. 8d., less cheque not presented, £12 8s. 6d.	102	9	2			
Ditto in hands of Treasurer	37	1	6½	139	10	8½
				£528	4	1½

12th April, 1859. HENRY M. ORMEROD, TREASURER.

Audited and found correct.

LIBRARIAN'S REPORT.

In the last Annual Report it was stated that the increase of the library, during the twelve months then elapsed, had been considerably greater than during any previous year. It is gratifying now to have to report that the additions during the year 1858-9 have been still more numerous, consisting of not less than 299 volumes, 177 parts of volumes, and 80 pamphlets.

These additions are, as usual, chiefly derived from the exchange of our publications with those of scientific societies and institutions in this and foreign countries, and presents received from government departments and private individuals; all of which, included under the general title of *Donations*, amount to 271 volumes., 161 parts of volumes, and 80 pamphlets. A specified list of these donations, will, as usual, be printed as an appendix to the Memoirs for the session.

The publications which the librarian is authorised to procure for the library by purchase, are

The London, Edinburgh, and Dublin Philosophical Magazine,
The Quarterly Journal of Pure and Applied Mathematics,
The Cavendish Society's Publications,
The Palæontographical Society's ditto,
The Ray Society's ditto,
Les Annales de Chimie et de Physique,
Poggendorff's Annalen der Physik und Chemie,
Journal der reinen und angewandten Mathematik,
Annalen der Chemie und Pharmacie,
Annals of Natural History, and
Journal de l'Ecole Polytechnique,

The set in the Library of the last-named Work to be completed up to the beginning of this year.

Of these publications, with the addition of a few volumes, partly obtained by exchange of some duplicates, and partly purchased to complete a work already in the library, 28 vols. and 16 parts have been placed on the shelves.

All the new acquisitions have been entered in the catalogue compiled in 1857 and 1858. It has been considered advisable to postpone the preparation of a new catalogue, until the result of a correspondence now in progress with a great number of scientific societies and institutions, for the purpose of introducing a mutual exchange of publications, shall be known, and the system of such exchanges shall thus have been more completely developed.

The library is gradually emerging out of the insignificance in which it had remained until within the last few years. The improvement is almost entirely owing to the exchanges referred to; but an improvement on that basis, to whatever extent it be carried, can never bring the library to a desirable state of completeness. The transactions and other publications of learned societies and institutions, which are thus obtained, are undoubtedly of the greatest value, and of course absolutely necessary in a scientific library; but still, they constitute only one of its chief elements. Scientific periodicals and separately printed works—the other elements—must as a rule, be bought. Every member of this Society, having for its chief object the advancement of science, cannot but feel the importance of rendering the library belonging to it as effective as possible. To point out that there exist great deficiencies, which can only be filled up by purchases, leads therefore evidently to only one conclusion: that the question of procuring funds for that purpose must be fairly taken up. A project, with that view, has been submitted to the Council, and, if approved of, will no doubt be recommended to the attention of the members.

As indicated in the last Annual Report, the subscription, authorised by the Society's resolution of the 20th October, 1857, for raising the amount required for fitting-up an additional library room, and for binding the books, and which was estimated at about £145., was kept open until the beginning of the session which is now closing. The final result is, that £89. 16s. have been subscribed by one honorary and fifty-six ordinary members; in stating which, it is but proper to observe that the appeal was exclusively made to the members of the latter class.

The expenditure up to the present moment, out of that fund, has been:

For fitting-up the new library room, altering and repairing old bookcases, and for a new library ladder	£25	2	6
Less defrayed out of the donation of £30. from the Watt Monument Committee	12	10	0
From the library fund	£12	12	6
For binding 2 vols. in folio and 59 vols. in 4to (average cost, nearly 4s. 5d. per vol.)	13	8	6
For binding 254 vols. in 8vo. (average cost, 1s. 11d. per vol.)	24	6	6
For cases, in the shape of books, to serve as receptacles for loose tracts, arranged alphabetically.	2	8	0
Total	£52	15	6
Leaving a balance of	£37	0	6

not yet disposed of. The binding of the books is, however, uninteruptedly proceeded with. Ninety vols., one half in 4to. and one half in 8vo., are now in the binder's hands, and nearly ready, and probably in one or two months from this day as many volumes as the disposable amount admits of, will have been substantially bound. The progress of binding may perhaps appear slow, but it has probably been much more to the advantage of the library to allow the binder to perform the work at his leisure and with care, than to run the risk of negligence by insisting upon unnecessary haste;

and, besides, the convenience of the members in using the books has also had to be consulted. It may be mentioned that the difference between the balance given above, and that in the Treasurer's balance sheet, arises out of alterations in the state of the fund after the closing of the Treasurer's account.

After some remarks by Mr. **Chadwick**, the Report was adopted on the proposal of Mr. **Curtis**, seconded by Dr. **Clay**.

The annual election of officers then took place, when the following gentlemen were elected:—

President.

WILLIAM FAIRBAIRN, F.R.S., Inst. Nat. Sc. Par. Corresp.

Vice-Presidents.

JAMES PRESCOTT JOULE, LL.D., F.R.S., F.C.S.
THOMAS HOPKINS, M. Brit. Met. Soc.
JOSEPH CHEESEBOROUGH DYER.
ROBERT ANGUS SMITH, Ph.D., F.R.S., F.C.S.

Secretaries.

EDWARD SCHUNCK, Ph.D., F.R.S.
RICHARD COPLEY CHRISTIE, M.A.

Treasurer.

HENRY MERE ORMEROD.

Librarian.

CHARLES FREDRIK EKMAN.

Of the Council.

REV. WM. GASKELL, M.A.
RICHARD ROBERTS, M. Inst. C.E.
JOSEPH BAXENDELL, F.R.A.S.
EDWARD WILLIAM BINNEY, F.R.S., F.G.S.
PETER SPENCE.
JOSEPH ATKINSON RANSOME, M.R.C.S.

Mr. **Dyer** moved, and Dr. **Joule** seconded, a vote of thanks to Mr. Ekman, the Librarian, for the valuable services rendered by him to the Society.

The Meeting was then adjourned to Tuesday the 3rd of May.

Adjourned Annual Meeting, May 3rd, 1859.

W. **Fairbairn**, F. R. S., &c., President, in the Chair.

The **Librarian** said, that he had much pleasure, on behalf of the widow of the late distinguished professor of the French language and literature, Monsieur Jobert, to present to the Society, with a view of distribution to the learned bodies with which the Society exchanges publications, about 100 copies of that gentleman's "Philosophy of Geology," and an equal number of his "Ideas," partly bound and partly in sheets. Different opinions will, of course, be entertained on the speculative views developed in these works; but all will agree that they are written with great eloquence in a remarkably pure language, and display a rare talent,—so much so indeed, that that eminent philosopher, the Rev. Professor A. Sedgwick, has thought one of them—the "Ideas"—deserving of a commendatory notice in his "Discourse on the Studies of the University of Cambridge." They will, therefore, no doubt, be worthy of the Society's acceptance, for the purpose mentioned.

On the motion of Dr. **Smith**, seconded by Mr. **Binney**, the thanks of the Society were voted to Mrs. Jobert.

"A Notice of the Geology of the Australian Gold Fields," by W. S. **Jevons**, Esq., late of the Sidney Mint, communicated in a letter to Professor Roscoe, was read.

"I was much interested when at the Braidwood diggings, in New South Wales, in speculating on the nature of the granite plateau, and the relations of it to the minerals encountered in gold washing. The section exhibited by a 'claim' is somewhat as follows:—

Vegetable soil 9 inches.
Ferrugineous Concretions. Strata of Granitose Sand of variable character.
Thin Strata of Clay, Mica, Sand, &c.
Washing Stuff.
Rotten Granite Bottom.

The 'washing stuff' forms the lowest stratum, varying in thickness from almost nothing up to two or three feet, but averaging two or three inches. It consists of:—

1. Coarse granitose sand.
2. Small quantities of clay.
3. Fine particles of yellow mica.
4. Gravel composed of felspar pebbles, chiefly red, sometimes green or other colours; and quartz either massive or crystalline, often in very large crystals.
5. Black iron (magnetic-titanite of iron), sand, and a few scarce pieces of hæmatite and specular iron ore.
6. Topaz sand.
7. Gold dust.

I found some reefs of quartz in the neighbourhood of the diggings, some of which had been tested for gold, but unsuccessfully. They run W.N.W. and E.S.E., whereas true auriferous reefs are said to be uniformly North and South in direction. In these reefs the quartz is supported between walls of felspar rock much decomposed. It appears to me that such reefs as these originate in the separation of the constituents of granite, but I have not heard of the same elsewhere. Now, the fact of gold being associated in the wash-dirt with fragments of quartz does not prove that it was derived from quartz reefs, because any large fragments of quartz or other rock remaining unbroken by the alluvial action would naturally be found in the lowest stratum. It appears to me probable, then, that the gold, as well as all the other minerals, are simply the components of the granite of the plateau. But such is the minute proportion of the gold, that it would scarcely be possible to extract it from granite. A ton of dirt seldom contains more than an ounce of gold, but the wash-dirt forms at the most $\frac{1}{10}$th part of the granite-debris even in rich hollows, and allowing for those parts which contain no gold, I should say that the granite will not contain more than $\frac{1}{1000}$ oz. to the ton, which would be quite inappreciable. I should also mention that I saw reefs or dykes of a dark ferruginous rock, probably trap, but running parallel with the other reefs; in the neighbourhood were large masses of porphyry, of which I have a small specimen."

Mr. H. M. Ormerod produced two specimens of iron used in building, which had both become oxydized so as to injure the buildings which they had been used to strengthen. One, an iron cramp, taken from the north-west buttress of Manchester Parish Church, about one foot long and three-eighths of an inch thick. This had become treble the thickness by rust, and had split the buttress, in the centre of which it was inserted, lifting about twelve feet of wall. It had been inserted about ninety years since. The other, a small wedge, from the steeple of St. Mary's Church, in Manchester, about three-eighths of an inch thick at the broad end originally, but now seven-eighths. These wedges had lifted all the stones which they were meant to keep in their places, splitting some, and allowing all the rain to penetrate. The steeple was erected about 1756, and the upper part has now become so ruinous and dangerous from the original faulty construction, and the expansion of the iron cramps and wedges, that it is being taken down, pursuant to notice from the city surveyor.*

A Paper, communicated by Dr. Smith, was read by its Author, Dr. ROBERTS, Physician to the Royal Infirmary, "On the Effect of Food on the Reaction of the Urine."

It has been the universal belief, until recently, that the reaction of the human urine is, in health, unfailingly acid, and that a neutral or alkaline condition of it was either a sign of disease or the consequence of partaking of subacid fruits, the vegetable salts of which became changed in the blood and appeared in the urine as alkaline carbonates.

In 1845, Dr. B. Jones called this belief in question, and announced that after ordinary food of any kind, whether animal, vegetable, or mixed, the acidity of the urine in an hour or two became depressed, and frequently even changed to neutrality or alkalinity; returning, however, again to its natural degree after the lapse of one or two hours. In the "Philosophical Transactions" for 1849, Dr. Jones brought forward a large number of experiments in support of this view.

Later experiments have failed to confirm the observations of Dr. Jones. Drs. Vogel and Bencke in Germany, and Dr. Sellers in Edinburgh, did not succeed in tracing any constant and direct relation between the digestion of food and the reaction of the urine.

The experiments detailed in this paper were undertaken with a view of throwing additional light on this dispute.

To that end the urine of a man 28 years of age, weighing 144lbs, in robust health, living in most favourable hygienic condition, was examined by hourly observations on 38 days.

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* After grinding and polishing the iron rust, it presented a black iridescent surface of almost metallic brilliancy, and similar, in appearance, to Elba ore. It was capable of being made into a magnet of considerable power and retentiveness.—J. P. J.

The acidity of the secretion was estimated by a test solution of caustic soda; and when it became alkaline, the alkalinity was ascertained by dilute sulphuric acid, in the usual way for volumetrical analyses. The observations commenced at seven, a.m., on leaving bed, when the night urine was discharged. At eight o'clock the bladder was emptied again, and thus the product secreted from seven to eight was obtained for examination. In the same manner, the urine was examined separately for each hourly period until noon. From noon until dinner the observations were made two-hourly. After dinner the urine was examined every hour until the sixth hour after that meal; and from that till bed-time every two hours.

In this way a minute record was obtained of the varying changes of the urine throughout the day and night.

Two meals a day were taken, breakfast always at eight, and dinner generally at two, p.m.; after which no food was taken till breakfast next morning.

In addition to the degree of acidity or alkalinity of each specimen, its exact quantity and specific gravity were also duly observed. From the two last the solids separated by the kidneys, during each hourly period, were calculated according to Dr. Christison's formula.

The effect of ordinary mixed food was examined on seventeen days; the effect of purely animal food (meat, eggs, milk, and cheese) on eight days; and that of purely vegetable food (bread, rice, sugar, and fresh vegetables, but no acid or sweet fruits) on nine days.

The results were similar in kind, whatever sort of food was taken; but vegetable food affected the urine less than mixed or animal diet. By living several days successively on vegetable food, the effect was greatly heightened, and on the third day of such diet, a breakfast of two pieces of dried toast and two cups of coffee made the urine alkaline in two hours.

The following propositions sum up the results obtained:—

1. The primary and direct effect of a meal was to lower the acidity of the urine. Sometimes the depression was slight, but more frequently the urine became neutral or alkaline.

2. After breakfast, the greatest depression occurred at the second hour, and the period of depression continued between two and four hours.

3. After dinner, the greatest depression took place at the third, fourth, and fifth hours, and lasted from four to six hours. The effect after dinner was stronger as well as more prolonged than after breakfast.

4. The urine became neutral or actually alkaline, after breakfast, twenty-three days out of thirty-eight; it became neutral or alkaline, after dinner, thirty-three days out of thirty-seven.

5. The effect of an ordinary mixed diet, and of purely animal diet, seemed almost identical. Vegetable diet, on the contrary, had decidedly a slighter effect; and unless it was used exclusively for some days in succession, the depression did not reach the neutral line.

6. After the period of depressed acidity had passed off the acidity of the urine rose again, so that at the ninth and tenth hours after a meal it was higher than before the meal. It was also invariably found that the morning urine was more acid when supper was taken the night before, than when the subject of experiment went to bed fasting.

7. Although, therefore, the primary effect of a meal was to depress the acidity of the urine, the secondary and remote effect was exactly the reverse.

8. This remote effect of a previous meal was found frequently to interfere with the primary effect of a recent meal. For this reason, the urine after breakfast rarely reached the neutral line if a hearty supper was taken the night before.

9. The alkaline urine after a meal owed its reaction to a fixed alkali. It did not contain ammonia. Generally it was turbid from precipitated phosphates *when passed;* but not unfrequently, however, it was clear, and once or twice it was clear when *strongly* alkaline. Its odour was very peculiar, and resembled exactly that of the urine of the horse. It was found rich in uric acid, also in earthy phosphates, the alkaline phosphates seemed only moderately abundant in it.

10. The emission of urine, turbid with phosphates, is therefore, within certain limits, a natural phenomenon, and earthy phosphates are the only urinary deposits which can appear in the urine before cooling, in the healthy state.

11. The depression of the acidity after a meal coincides in point of time with chymification rather than with digestion. The solids of the urine began to increase simultaneously with the declension of its acidity. So that the passage of food into the blood, and the diminished acidity of the urine seemed to be connected together as cause and effect.

12. Liebig has pointed out that phosphoric acid and the alkalies are present in such proportion in bread, meat, and our ordinary food, that if we suppose them dissolved, the alkalies invariably preponderate. Hence arises, he says, the alkalinity of the blood.* If this be so, every meal that is dissolved and absorbed into the blood must increase the alkalinity of that fluid, and raise it for a time above the natural level. But it is well known that the kidneys are the unique channel by which fixed alkalies given as medicines pass through the system, and in their traject they render the urine alkaline. And what is a meal, viewed in this light, but a dose of alkali? This explanation accords perfectly with the statement in proposition 11.

Dr. Joule having taken the Chair, a Paper was read by the President, W. Fairbairn, F.R.S., entitled "Experiments to Determine the Effects of Different Modes of Treatment on Cast Iron for the Manufacture of Cannon."

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* "Familiar Letters," letter 28.

After commenting upon the importance of the treatment of iron in the manufacture of cannon, and on the want of knowledge upon this subject, exhibited in the failure of many of the guns employed in the Russian War, the Author proceeds to describe the processes usually adopted in the foundry for the improvement of iron, under the heads mixing, remelting, and prolonged fusion. The value of remelting and mixing iron has long been recognised, and their effect in increasing the tenacity of the metal has been fully demonstrated by experiments. Lately the influence of prolonged fusion had also been the subject of inquiry, and the conclusion had been arrived at that a continued exposure of liquid iron, to an intense heat, augments the cohesive powers of the iron in proportion to the duration of the exposure, up to some not well ascertained limit where the opposite effect begins to be produced, and the iron deteriorates.

The Author then proceeds to narrate the results of some experiments in which he was engaged in 1855, on the improvement of cast iron ordnance. Five twenty-four pounder guns were cast of a carefully selected mixture of the following qualities of iron.

Blaenavon,	No. 1	.... 2.2	per cent.
Blaenavon,	No. 2	.........16.7	,,
Blaenavon,	No. 3	.........28.9	,,
Lilleshall,	No. 2	.........35.5	,,
Pontypool,	No. 3	.........16.7	,,

In casting these guns it was sought to determine the effect of various modes of treatment in the foundry: hence,

Gun A was cast in the usual way, with 3 feet 6 inches head.

Gun B was cast from the air furnace, of iron remelted once before casting into the mould.

Gun C was cast from the cupola, with desulphurized coke.

Gun D was cast from the air furnace in the usual way, under a pressure of 17 feet 6 inches of head.

Gun E was cast from iron remelted once, and then run into mould, under 17 feet 6 inches head of metal.

These guns having been bored and turned, were conveyed to Woolwich Marshes, and subjected to proof by firing, beginning with the usual proof charges, with a gradually increasing quantity of powder and weight of shot, until the gun burst. The result of these proofs is exhibited in the following table:—

Gun.	Number of Rounds Fired.	Total Quantity of Powder used, in lbs.	Total Weight of Shot Fired, in lbs.	Total Number of Wads used.
A	33	364	3120	91
B	32	350	2952	90
C	17	150	1152	43
D	31	336	2784	89
E	33	364	3120	91

From this table it will be seen that, whilst the gun cast with desulphurized coke from the cupola, exhibited comparatively a great inferiority.* The guns E and A, one of which had been cast in the ordinary way, and the other with remelted iron, under pressure, exhibited very high powers of resistance. The results thus obtained were further confirmed by experiments upon the tenacity and density which gave the following mean results:—

Gun.	Density.	Tenacity in lbs. per sq. in.
A	7.2105	28,516.
B	7.2325	27,219.
C	7.0863	18,101.
D	7.2032	25,954.
E	7.2441	28,516.

* Considerable want of uniformity is observable in iron melted in the cupola, unless retained for some time in a state of ebullition at a high temperature. This will account for the comparative weakness of the gun C, which, under different treatment, would have been greatly improved by the use of desulphurized coke, as was found to be the case in former experiments.

After discussing the results of these experiments, in some respects anomalous, gun A being a peculiarly fortunate cast, it appeared that the other guns were improved by the remelting and pressure of head, so as to give the best result with E, which had been subjected to both these processes. In conclusion the Author alludes to experiments on guns cast with a core, and expresses his belief that the great practical difficulties which beset that process must prevent its application, although theoretically calculated to produce guns of greatly increased strength.

Ordinary Meeting, October 4th, 1859.

Wm. Fairbairn, Esq., F.R.S., &c., President, in the Chair.

The President delivered an address on the occasion of the opening of the session.

He commenced by adverting to the loss which had been sustained by the Society by the death of two of its Ordinary and two of its Honorary Members.

Mr. Laurence Buchan was elected in November, 1810, and was at the time of his death the oldest member of the Society. He was a man of liberal views and large intellectual capacity, and was for a long succession of years devoted to the well-being of the Society, on the Council of which he served for several years. He died at the advanced age of eighty-four years, deeply regretted by all who had the advantage of his friendship.

Mr. John Ashton Nicholls, F.R.A.S., was on the other hand suddenly called away in the prime of life. He had early manifested a taste for Astronomy, and although his time was chiefly occupied with public affairs, he continued to cultivate and to aid in the promotion of his favorite science. The educational establishments of the city have lost in him an able and most zealous supporter.

The Honorary Members who have passed away are Alexander von Humboldt and the Rev. William Turner. The world-wide fame of the former renders it unnecessary to dwell upon the immense services he has rendered to science. He died in his ninetieth year covered with honors and followed by universal regrets. The Rev. William Turner, uncle to the Member of Parliament for this city, was one of the Founders of the Society. He contributed a paper to the Memoirs, entitled "An Essay on Crimes and Punishments," as early as March 24, 1784. After his removal to Newcastle-upon-Tyne, where he spent the greater portion of his useful life and formed the friendship of Dalton and

Davy, he established the Literary and Philosophical Society of that town. Returning to this city, he spent the last few years of his life among his relatives and intimate friends, dying highly respected in his ninety-eighth year.

The President reviewed the past history of the Society, pointing out what had been accomplished by the members, and the path still open for successful scientific research. He adverted to the great advances made in recent times in all the departments of knowledge. By the organization of the British Association, and the improved systems which were beginning to obtain in our Universities, greater facilities were at present offered to the cultivators of science than at any previous period. In conclusion he congratulated the Society on its prosperous state, and expressed the fullest confidence that the members would, by their contributions to literature and science during the present session, fully maintain its reputation.

On the motion of Mr. **Dyer**, seconded by Mr. **Hopkins**, the thanks of the Society were voted to Mr. Fairbairn for his excellent address.

Dr. F. **Crace Calvert** presented, on the part of Mr. Arnaudon, of Turin, a Paper containing "Researches on several Organic Coloring Matters."

The most remarkable of these researches is one concerning nine different species of wood, termed by the Author, collectively, *bois d'amarante* (and one of which is known in England under the name of purple heart), on account of their containing a peculiar colorless principle capable of being transformed into a substance of fine purple color by the action of light, heat, and acids. Oxygen is unnecessary to this transformation, as it takes place equally in an atmosphere of hydrogen or in vacuo. A solution of the colorless principle exposed to the action of air during several years, in a dark place, remained perfectly unaltered.

The purple coloring matter differs entirely from the colorless principle from which it is obtained, not only by its color, but also by other physico-chemical properties; thus, for instance, it is less soluble in water and in ether, more volatile, and contains a greater proportion of carbon, than the colorless principle. It may be reduced in the same manner as indigo blue.

Amongst the many interesting experiments which may be performed with this coloring matter, and of which several were repeated during the evening, we may mention the following. A quantity of the colorless solution is introduced into a glass tube, from which the air is then expelled, and the tube hermetically closed. If the tube be now exposed to the direct rays of the sun, the solution assumes a purple color, and red flakes of coloring matter are deposited. When acidulated with hydrochloric acid, the colorless solution acquires a purple hue when heated up to 80° C. If the colorless principle in the dry state be enclosed in a tube containing hydrogen, or devoid of air, and exposed to a temperature of 160° C., in the dark, the purple colour is at once produced.

The wood and its decoction show the same phenomena, but with less intensity. Woollen, silk, and cotton stuffs, with or without mordant, steeped in this decoction have only a brown or greyish hue, as long as the original substance has not been modified. But when so prepared they are exposed to the action of light or heat, or immersed in a bath of acidulated water, they are at once dyed of a purple hue.

The colour thus produced withstands perfectly the action of acids, it is rendered slightly more blue by alkalis, and resists light better than archil purples and aniline.

A second research is on the Bois de Taigu, from Paraguay (or Ebène soufré), from which the Author has separated an acid principle, which crystallizes in beautiful yellow prisms, and yields crystallizable salts of a scarlet colour.

Then follows a notice on the Quebracho wood of South America, from which Mr. Arnaudon has produced a fine yellow on wool.

Violet Palisander wood (Madagascar), contains a violet coloring matter which differs from that of the bois d'amarante, and may be fixed in the same manner as the coloring matter of Logwood.

In a last notice on the coloration of the solution of guaiac resin, the Author shows by experiments that it is produced only by the action of oxygen.

From general considerations deducted from comparative experiments set down by him in tabular form, Mr. Arnaudon concludes that, with our present chemical knowledge, general laws for the production of organic coloring matters cannot be laid down.

A Paper by Mr. John Smith, M.A., was read by his brother, Dr. R. A. Smith, entitled "On the cause of Colour and the Theory of Light."

The Author, in attempting to explain certain natural phenomena, could not satisfy himself by applying the principles of either theory of light, and said that many natural phenomena indicated beats or vibrations in the luminous ether very different from what science taught. That is, that there were greater intervals between them than Newton had demonstrated and scientific men believed. He therefore endeavoured to contrive experiments by which he would be able to make as many revolutions or beats in a second as he considered the effective vibrations of light were repeated in a second of time, and argued that by certain contrivances to produce light and shade in alternate vibrations he should produce colour. A series of experiments was subsequently undertaken, which led to the conclusion that varieties of colour are produced by pulsations of light and intervals of shadow in definite proportions for each shade of colour. That is, supposing white light to consist of the motion of an ether, blackness to consist of an entire absence of motion, then a certain colour, blue, red, or yellow, will be produced by the alternate action of the light and the shadow. The Author used shadow in the positive sense as the sensation was positive.

On pursuing the inquiry, he first caused a small parallelogram cut in card board to revolve over a black surface with a rapidity which he considered equal to the vibration of light. By this motion he obtained a distinct blue, while at another time in different weather he obtained a purple. He then made a disc with several concentric rings, which he painted respectively $\frac{1}{3}$, $\frac{2}{3}$, $\frac{3}{4}$, and $\frac{1}{2}$ black, leaving the remainder white, and on making this disc revolve the rings became completely coloured. There was no appearance of any black or white. In a bright day with white clouds in the sky the rings were coloured respectively a light yellowish green, two different shades of purple, and a pink. By using discs of a great variety of shapes and different proportions of white and black, the Author said that he produced sucessively or together all the colours of the rainbow, although he had not yet arrived at the exact arithmetical determination of the amount of light and shade needful for each.

These experiments were made before the Society by the light of a paraffin oil lamp with a reflector. The Author said that they were much more brilliant by sunlight.

There was another set of experiments which the Author considered as very effective, and especially as being easily made and described, but requiring strong sunshine to show them. These were made by casting a shadow of a particular figure on a white wall or on a sheet of paper, so as to produce alternate beats of light and shadow when put in revolution. The figure became coloured of different shades, and because these could be seen on the wall, like the spectrum from the prism, he called them spectra by reflection.

He mentioned also that the colours may be produced by making a black disc, with figures cut out of it, revolve before a white cloud or white screen.

There were many others which he had no time to enumerate, much less to describe, but he described some of the figures which produce the phenomena which are perceived when looking through transparent solids.

The Author considered that his theory gave an entirely new and simple explanation of the phenomena of refraction through the prism, and summed up as follows :—

The experiments prove the homogeneity of the ether.

They prove the undulatory hypothesis, but oppose the undulatory theory.

They enable us to dispense with the different refrangibilities of the rays of light, as taught by Newton.

They help to explain many of the phenomena of what is called the polarization of light.

They give a new explanation of prismatic refraction, and explain in a plain and simple manner many very interesting natural phenomena.

Startling, he said, as these conclusions are to those who are conversant with the subject of light, he thought he was perfectly warranted in drawing them from his experiments. The general process of reasoning could not, however, be given in a short abstract.

Quarterly Meeting, October 18th, 1859.

WM. FAIRBAIRN, Esq., F.R.S., &c., President, in the Chair.

The PRESIDENT announced the formation of a Mathematical and Physical Section in connexion with the Society.

Dr. F. CRACE CALVERT presented in the name of Mr. Arnaudon (from Turin), a Paper, and Samples of Green Colours used in Painting and Printing, and especially referred to two new chrome greens, one of which is a new compound, corresponding to the monohydrate of sesquioxyde of chrome $Cr^2 O^3 HO$.

The Author commences in his work to point out the qualities which a good green ought to possess, in order to be suitable for painting. Then he reviews in a few words the different greens which are found at present in the market, together with the nature and properties of the same. Beginning with the history of the works already published on this subject, he next gives the description of his process for preparing his monohydrate of sesquioxyde of chrome, and which consists in exposing the bichromate of potash mixed with phosphoric acid and any desoxydizing agent (for example, ammonia) for some time to the action of heat. The soluble salts are then removed by washing.

The green so prepared has not only a beautiful shade, but like that of Mr. Guignet (made by decomposing the borate of oxyde of chrome by water) possesses the curious property of remaining green under the influence of artificial light.

Dr. CALVERT also presented some Muslins printed by M. Camille Kæchlin, of Mulhouse, with Fuchsine, a product obtained from the Aniline of Coal Tar. This colour was very remarkable from the exquisite bloom of the pink shade obtained when fixed with Albumen.

The following extract of a letter received from Professor W. Thomson, F.R.S., Honorary Member of the Society, &c., was read by Dr. Joule.

"I have a very simple 'domestic' apparatus by which I can observe atmospheric electricity in an easy way. It consists merely of an insulated can of water to set on a table or window sill *inside*, and discharge by a small pipe through a fine nozzle two or three feet from the wall. With only about ten inches head of water and a discharge so slow as to give no trouble in replenishing the can with water, the atmospheric effect is collected so quickly that any difference of potentials between the insulated conductor and the air at the place where the stream from the nozzle breaks into drops is done away with in my apparatus at the rate of five per cent. per half second, or even faster. Hence a very moderate degree of insulation is sensibly as good as perfect, so far as observing the atmospheric effect is concerned. It is easy, by my plan of drying the atmosphere round the insulating stems by means of pumice stone moistened with sulphuric acid, to insure a degree of insulation in all weathers, by which not more than five per cent. per minute will be lost by it from the atmospheric apparatus at any time. A little attention to keep the outer part of the conductor clear of spider lines is necessary. The apparatus I employed at Invercloy stood on a table beside a window on the second floor, which was kept open about an inch to let the discharging tube project out without coming in contact with the frame. The nozzle was only about two feet and a half from the wall, and nearly on a level with the window sill. The divided ring electrometer stood on the table beside it, and acted in a very satisfactory way (as I had supplied it with a Leyden phial consisting of a common thin white glass shade, which insulated remarkably well, instead of the German glass jar—the second of the kind which I had tried, and which would not hold its charge for half a day).

"I found from 13¼° to 14° of torsion required to bring the index to zero when urged aside by the electromotive force of ten zinc-copper water cells. The Leyden phial held so well, that the sensibility of the electrometer measured in that way did not fall more than from 13½° to 13¼° in three days.

"The atmospheric effect ranged from 30° to above 420° during the four days which I had to test it—that is to say, the electromotive force per foot of air measured horizontally from the side of the house was from nine to one hundred and twenty-six zinc-copper water cells. The weather was almost perfectly settled, either calm, or with slight east wind, and in general an easterly haze in the air. The electrometer twice within half an hour went above 420°, there being at the time a fresh temporary breeze from the east. What I had previously observed regarding the effect of east wind was amply confirmed. Invariably the electrometer showed very high positive in fine weather, before and during east wind. It generally rose very much, shortly before a slight puff of wind from that quarter, and continued high till the breeze would begin to abate. I never once observed the electrometer going up unusually high during fair weather without east wind following immediately. One evening in August I did not perceive the east wind at all, when warned by the electrometer to expect it; but I took the precaution of bringing my boat up to a safe part of the beach, and immediately found by waves coming in that the east wind must be blowing a short distance out at sea, although it did not get so far as the shore.

"I made a slight commencement of the *electro-geodesy* which I pointed out as desirable at the British Association, and in the course of two days, namely, October 3rd and 4th, got some very decided results. Macfarlane, and one of my former laboratory and Agamemnon assistants, Russel, came down to Arran for the purpose. Mr. Russel and I went up Goatfell on the 3rd inst. with the portable electrometer and made observations, while Mr. Macfarlane remained at Invercloy, constantly observing and recording the indications of the house electrometer. On the 4th inst. the same process was continued to observe simultaneously at the house and at one or other of several stations on the way up Goatfell. I have not yet reduced all the observations, but I see enough to leave no doubt whatever but that cloudless masses of air at no great distance from the earth, certainly not more than a mile or two, influence the electrometer largely by electricity which they carry. This I conclude because I find no constancy in the relation between the simultaneous electrometric indications at the different stations. Between the house and the nearest station the relative variation was least. Between the house and a station about half way up Goatfell, at a distance estimated at two miles and a half in a right line, the number expressing the ratio varied from about 113 to 360 in the course of about three hours. On two different mornings the ratio of house to a station about sixty yards distant on the road beside the sea was 97 and 96 respectively. On the afternoon of the 4th inst., during a fresh temporary breeze of east wind, blowing up a little spray as far as the road station, most of which would fall short of the house, the ratio was 108 in favour of the house electrometer—both standing at the time very high—the house about 350°. I have no doubt but that this was owing to the negative electricity carried by the spray from the sea, which would diminish relatively the indications of the road electrometer."

A Paper was read by Mr. HOPKINS, entitled "On Irregularities in the Winter Temperature of the British Islands."

This Paper was a continuation of one previously read to the Society, in which it was maintained that the superior warmth of the British Islands in the winter, is due to the large amount of vapour that is then condensed over them. To this proposition an objection has been taken, that the degree of warmth experienced in the locality is not always proportioned to the condensation of vapour as indicated by the fall of rain. This was admitted, but it was contended that the objection taken did not invalidate the general proposition. It was then shown that when vapour was condensed in abundance and the local atmosphere thereby much heated and expanded, the adjoining heavier air forced the lighter to ascend to upper regions, conveying the liberated heat of the condensation with it to warm those regions, and of course leaving the lower air unheated. But in the winter when the vapour was supplied from the ocean in more moderate quantities, at the time that the surface of the earth was cold, the vapour was condensed by that cold, and gave out the heat of elasticity near the surface. In this way it was shown that ice was often formed on very cold ground; and mist and fog produced, at moderate heights, over land not so cold, leaving the liberated heat of vapour to warm the lower regions. And this warmth remains near the surface when the condensation takes place during thick fogs and light drizzling rains, because there is not sufficient heat set free to produce an ascending aerial current. The western coasts of Ireland and Scotland in the winter are in this way enveloped in a warm mist, a thick fog, or a small drizzling rain, which gives out a considerable amount of heat that remains in the lower regions, thus raising their temperature. The same processes take place over England and the whole of the western coast of continental Europe, making them misty and warm in proportion to the extent to which vapour is condensed over them, as compared with parts farther east in the same latitudes. Instances were quoted of this kind of heating in northern mountainous countries.

In the course of the discussion which followed the reading of the Paper, the Rev. W. N. Molesworth supported the hypothesis that the favorable climate enjoyed by Great Britain was in a great measure owing to the influence of the Gulf Stream. He believed also that a current existed in the Pacific Ocean, near the western coast of North America, by which a warm stream was carried from the tropics to higher latitudes, thus raising the annual temperature of Vancouver and Queen Charlotte's Islands, and the neighbouring coasts.

Mr. HOPKINS, in reply, remarked that the existence of the latter oceanic current had not been established by any satisfactory proofs.

Ordinary Meeting, November 1st, 1859.

J. P. **Joule**, LL.D., F.R.S., Vice-President, in the Chair.

Attention was drawn to the extreme depression of the barometer which had occurred during the day. About noon, in Manchester, the mercury stood at 28·4 inches. At Belfield, near Rochdale, Dr. Schunck observed an atmospheric pressure of only 28·12 at nine o'clock, a.m.

The **Chairman** stated that he had received a letter from Professor Thomson, explaining that, although he had mentioned five per cent of loss per minute as a perfection of insulation easily attained in his apparatus, he found that by carefully selecting the glass stems, and having the atmosphere in which they are placed well dried by sulphuric acid, the loss by imperfect insulation of the testing conductor might readily be diminished to five per cent. per hour. He had found also that the Leyden phial, to the inside coating of which the index was connected, did not lose as much as one per cent. per day even when the instrument was exposed to sea spray in a boat, to rain, and to fog, besides experiencing great changes of temperature.

N.B. The observations recorded in the last number of the Proceedings, as having been made on the 3rd and 4th of October, were made on the 10th and 11th of that month.

A Paper was read by Mr. **James G. Lynde**, M. Inst. C.E., F.G.S., entitled, "Experiments on the Strength of Cast Iron Girders."

The Paper was accompanied by a diagram, shewing the rrangement of the apparatus made use of in the experiments and the dimensions of the beams referred to.

The beams experimented on were eighty-nine in number, and were cast by Mr. Mabon, at the Ardwick Iron Works, Manchester, from iron of the following descriptions:—

One charge of the cupola consisted of

12 cwt. Goldendale, Staffordshire.
12 ,, Lane End, ,,
12 ,, Ormesby, Yorkshire.
12 ,, Blair, Scotch.
12 ,, Calder, ,,
All No. 3 hot blast iron.
12 ,, scrap.

The beams were cast on their sides, and were a very good sample of workmanship.

The section of each beam was of the form recommended by Professor Hodgkinson, and upon which his formulæ were based; the total depth of the beam in the centre was $24\frac{1}{4}$ inches, and at the ends 20 inches; the bottom flange was 15 inches wide, and $2\frac{1}{4}$ inches thick; the vertical part of the beam was $1\frac{1}{2}$ inch thick; and the top flange was $4\frac{1}{8}$ inches wide, and $1\frac{1}{2}$ inch thick; the total length of the beam was 34 feet 6 inches, and the distance between the supports was 30 feet 9 inches; the weight of the beam was 3 tons 8 cwt. 1 qr.

One of the beams was tested up to the breaking weight with the following results:—

	Tons.	Cwt.		Inch.
With a load in the centre of	31	8	the deflection was	.87.
,, ,,	42	16	,,	2.00.
,, ,,	46	12	,,	2.25.
,, ,,	50	8	,,	2.56.
,, ,,	54	4	,,	2.70.
,, ,,	58	0	the beam broke,	

the ends springing back from each other 2 feet 3 inches, the fracture indicating a good sound casting.

There was no permanent set observable in any of the experiments, until the breaking weight was applied, the beam being allowed to recover itself on the removal of the load in each case.

Each of the remaining beams was tested with a load of 20 tons in the centre, the deflection varying from $\frac{5}{8}$ths to $\frac{7}{8}$ths of an inch.

The calculations for the strength were based on the following formulæ, given by Professor Hodgkinson in his "Experimental Researches on the Strength and Properties of Cast Iron:"—

First formula, art. 146:

Let $W =$ the breaking weight in tons placed on the centre of the beam,
$a =$ the area of the bottom flange in inches,
$d =$ the total depth of the beam in inches,
$l =$ the length between the supports in feet,

$$\text{then } W = \frac{2.166\ a\ d}{l}$$

In this case

$$a = 36,$$
$$d = 24.25,$$
$$l = 30.75,$$

which gives 60.09 tons as the breaking weight of the beam.

The second formula, art. 147, takes into account the thickness of the vertical part of the beam, and is as follows:—

Let $W =$ the breaking weight in tons placed on the centre of the beam,
$l =$ the length between the supports in feet,
$b =$ the breadth of the bottom flange in inches,
$b' =$ the thickness of the vertical part in inches,
$d =$ the whole depth in inches,
$d' =$ the depth from the top of the beam to the upper side of the bottom flange in inches,

$$\text{then } W = \frac{2}{3\,d\,l}\left(b d^3 - (b - b')\,d'^3\right)$$

In this case

$$l = 30.75,$$
$$b = 15,$$
$$b' = 1.5,$$
$$d = 24.25,$$
$$d' = 22.03,$$

which gives 62.19 tons as the breaking weight of the beam.

The actual breaking weight being 58 tons, it would appear that the constant coefficient assumed is in each instance too high for the quality of iron of which these beams were cast. This result appears to have been anticipated by Professor Hodgkinson in the case of large beams; and in one of his experiments, art. 147, on a beam cast for Messrs. Marshall and Co., of Leeds, he gives .625 as the coefficient, which agrees with the result of this experiment.

Applying this coefficient to Professor Hodgkinson's formulæ, they will be as follows :—

First formula, $W = \frac{2.05\, a\, d}{l}$

Second formula, $W = \frac{.625}{d\, l}\left(bd^3 - (b - b')\, d'^3\right)$

The first of these would give 58.2 tons, and the second 58.31 tons, as the breaking weight; either of which calculations would be sufficiently correct for any practical purpose.

MATHEMATICAL AND PHYSICAL SECTION.

October 5th, 1859.

The following gentlemen were elected Officers of the Section, for the present year :—

President, Robert Worthington, F.R.A.S.

Vice-Presidents, J. W. Long, F.R.A.S.
E. W. Binney, F.R.S., F.G.S.

Treasurer, Joseph Baxendell, F.R.A.S.

Secretary, Mr. Thos. Heelis.

October 13th, 1859.

Mr. Baxendell read a Paper "On the Phenomena of Groups of Solar Spots."

After alluding to the conclusions which have been drawn from the observations of the solar spots made by M. Schwabe, Mr. Carrington, Mr. Dawes, Professor Secchi, and Dr. C. H. F. Peters, the Author describes certain phenomena of groups of solar spots, which, so far as he is aware, have not hitherto been noticed in any astronomical work or memoir, but which he thinks merit attention as indicating the direction in which future inquiries ought to be made.

1. In groups consisting of spots differing considerably in size, the largest spot is generally in the preceding part of the group. An examination of many of the published drawings and descriptions of the solar spots by former observers, and of an unpublished series of diagrams made by Mr. Williamson, of Cheetham Hill, in the years 1849, 1851, and 1859, has confirmed the conclusion drawn from the Author's own observations.

2. A great number of groups may be regarded as consisting of two *sub-groups*, each containing one or two spots decidedly larger than the rest. These sub-groups may in their early stages have no apparent connexion, but sooner or later small spots generally break out in the interval between them and complete the group. The preceding sub-groups of binary groups are generally the first to appear and the last to disappear. Amidst all the changes to which groups of spots are liable, there seems to be a general tendency to assume the binary arrangement; and it often happens that groups which have apparently quite lost their original binary character, again resume it before their final decay and extinction. Mr. Williamson's diagrams contain many groups which exhibit the binary character; and from the descriptions of the solar spots given by former observers, there can be little doubt that groups of this class have at all times been of common occurrence. An observation of Sir William Herschell, in January, 1801, is quoted as an illustration. The two centres of force or activity in binary groups are sometimes very widely separated, instances not uncommonly occurring in which the distance between them exceeds 90,000 miles.

3. Groups which exhibit anomalous appearances, and undergo complicated changes, sometimes consist of two binary groups which have originally broken out near each other and have extended themselves until they form one compound group.

4. Spots which exhibit indications of rotation are generally the principal members of preceding sub-groups; but the Author considers that his observations are far from being conclusive as to whether this rotation is real or only apparent.

It is difficult to conceive the mode of operation by which the forces that produce the spots in a binary group should first develope themselves—sometimes almost simultaneously—at *two* points so widely distant from each other; and the

Author admits that in the present state of the inquiry he is not prepared to offer any theoretical explanation of this remarkable phenomenon. His observations have been made without reference to any particular theoretical views; and, at present, he does not offer the conclusions given in his Paper as anything more than the first results of an attempt to pursue, without reference to any theory, a systematic examination of the phenomena of the solar spots.

Extracts from the Author's journal of observations were given to illustrate the several points to which he has drawn attention.

In the discussion which followed, Mr. WILLIAMSON exhibited diagrams shewing the results of his observations upon the sun, up to and inclusive of those made on the 13th instant.

Mr. HEELIS also produced, for the inspection of the members, a copy of the "Selenographia" of Hevelius, including his observations upon the solar spots.

Messrs. SIDEBOTHAM and HEELIS also stated that the conclusions drawn by Mr. Baxendell were partly confirmed by their own observations.

A Paper was read by Mr. THOMAS CARRICK, "On the Relation which appears to subsist between Orbit *Distances* and Orbit *Inclinations*, when the latter are referred to the Solar Equator as a fundamental plane."

Taking orbits of each kind in groups successively receding from the sun, there is—with the exception of the planetoids—a progressive increase in the mean inclination of each group, as under:—

PLANETS.	Inclination.
4 minor planets	4°.89.
50 planetoids................................	9°.60.
4 major planets	5°.76.

COMETS.

11	comets with periods under 6 years............	10°.28.
2	,, ,, from 6 to 16 years......	39°.52.
13	,, ,, from 16 to 1000 years..	47°.35.
175	,, with still longer or undetermined periods	50°.65.

Ordinary Meeting, November 15th, 1859.

Mr. J. C. Dyer, Vice-President, in the Chair.

Mr. John Atkinson made a communication respecting a curiously-shaped fossil, found about a month ago in the Upper New Red Sandstone in a quarry near Runcorn. This fossil had been described in the *Athenæum* of the 29th of October last by Mr. Henry Wilson, Surgeon, Runcorn, who pointed out its striking resemblance to the mullion and tracery of part of an ancient gothic window, not merely in size and general outline, but in the moulding upon it, as if of tooling by the hand of some primitive mason. On the 5th instant the *Athenæum* contained two letters on the same subject, the first from Mr. Jukes, Local Director of the Geological Survey of Ireland, and the second from Mr. Archer, of Liverpool. Neither of the writers had seen the fossil. From the description given of it, Mr. Jukes expressed his belief that the "quadrilateral mullion and tracery" described by Mr. Wilson was nothing more than an unusually large and regular example of sandstone veins formed in the cracks of a bed of clay intervening between two strata of sandstone. Mr. Archer thought it was a dichotomous branch of the great fucoid plant which had been discovered at Stourton Hill Quarry nearly twenty years ago. Opinions being thus divided, Mr. Atkinson stated that he had visited the Runcorn Hill Quarry and examined the fossil itself; and that he had found it to be, as Mr. Jukes had suggested, a mass of fine-grained sandstone veins. These had been deposited in thin horizontal laminæ and moulded in a system of cracks formed by desiccation and subsequent modification—probably by the action of water—in the bed of marl (here eight inches thick) so celebrated as being that on which the last of the Labyrinthodon order of animals have left their footprints in such vast abundance at Stourton, Runcorn, Lymm, and various other localities. Mr. Atkinson exhibited to the meeting a photographic view of this fossil, which had been kindly lent to him by Mr. H. Wilson, of Runcorn, and then went on to point out the manner in which, after the curious system of cracks had been made by desiccation, he considered it probable the shape of the cracks had been changed by the action of water so as to form a mould which produced the grooves or fillets at the upper edges that had given rise to the idea of "*tooling, as by the hand of some primitive mason.*"

Mr. Binney said that he had noticed these very markings in a paper read before this Society so far back as December, 1846, and printed in vol. viii, p. 168, of the Society's Memoirs. The following is the extract: "In the upper new red sandstone of Weston Bank, near Runcorn, in Cheshire, we have the first positive evidence hitherto discovered of dry land in England. At Weston, in the rock above-named, about thirty-two feet from the surface, and in the higher part of the deposit, there is a thin bed of red clay from about half to three-quarters of an inch in thickness. This clay affords impressions of the feetmarks of the *Cheirotherium Rhynchosaurus* and several other reptiles, numerous worm marks, and beautiful lines of desiccation, similar to what a bed of moist clay would undergo under a hot sun at the present day. The red clay was evidently deposited by water, which afterwards receded from it and left it uncovered. When this deposit was in a plastic state, the animals walked across it and left their tracks. Subsequently, the sun or air by desiccating the clay produced wide cracks, and the water at length returning, again filled both the feetmarks and cracks, and made a beautiful cast of them in sand. Thus do these most interesting specimens not only show us the tracks, left countless ages ago, of some of the most extraordinary animals that ever existed on our globe, but they afford us proofs of a very quiet flow of water that deposited the red clay—the recession of such water—the drying and cracking of the clay by a hot sun or air, and the return of a sharp current of water bearing along with it the sand that formed the casts of the moulds—circumstances of great interest to all who speculate on the physical condition of the globe at that remote period."

Mr. **Baxendell** stated that Mr. Heelis had received a letter from Mr. May, of Westminster, relative to the remarkable atmospheric pressure on the 10th inst. Mr. May's barometer, situated at an elevation of twenty-five feet above the mean level of the sea, stood at eleven a.m. on that day so high as 30·804, the temperature being 53°. Mr. Baxendell added that the reading of the barometer in Manchester was almost identical with that in London, allowing for the difference of altitude.

Professor **Roscoe** communicated a Paper by W. S. Jevons, Esq., late Assayer in the Sydney Branch of the Royal Mint, entitled, "Observations on the Gold Districts of Australia." The Paper was illustrated by numerous specimens of the rocks and deposits in and near which the gold is found; as also by some photographic views, showing the general character of the country, and by geological maps and sections.

The Author first discussed the special geological features of the several diggings of Victoria—Bendigo, Ballarat, Creswick Creek, &c. In these diggings the gold is found in two distinct forms, viz., in alluvial deposit as "wash gold" in fine grains, and disseminated through the solid quartz rock. In the Author's opinion the whole of the gold found in Victoria, is in the first instance derived from the "reefs" or dykes of more or less pure quartz which intersect both the granite of the country, and the overlying slate which is proved to be of the older silurian formation. The gold now found in the alluvium is supposed to be derived, together with the whole detritus, from the disintegration of the formerly existing schistose or granite hills penetrated by the auriferous quartz reefs. This opinion is confirmed by the fact that the channels in the lower portion of the alluvium called the "wash-dirt," in which alone the gold is worked, are unconformable to the present surface, and run in many cases, especially at Ballarat, in a totally different direction from the existing schistose hills. In this quartzose and slaty detritus, at the depth of often three hundred feet below the surface, the remains of the ancient Australian vegetation are found in large quantities, the gold occurring in small grains in the lowest portions of the deposit. A singular widely extended bed of recent basalt covers the country for several hundred square miles near Melbourne and Ballarat, the elevated cones of several extinct volcanoes being visible from both places. This coating of basalt has to be penetrated before the auriferous drift can be worked, and for some time the existence of gold deposits below the basalt was unknown.

At Ballarat there occur also several of the auriferous quartz reefs, which are being worked with great success, regular and well organised companies raising the quartz for the crushing and amalgamation processes. Specimens showing the character of the quartz reef in various positions, as also specimens of the silurian schist which had been more or less altered by the action of the quartz, were exhibited.

Other interesting gold-producing localities in Victoria and New South Wales, viz., Tarrengower, Adelong, Braidwood, &c., are next described; the general geological features being the same, and bearing out Mr. Jevons's idea, that all the gold is derived from the granite quartz reefs.

At the close of the Paper the Author considers the important question of the probable future yield of gold to be expected from Australia. He believes that no more very large or rich fields of alluvial gold will be discovered in Victoria, but that the present "gold-drift" has by no means been worked out; so that when capital and more complete mechanical appliances are brought to bear upon the ground which the first gold-digger has relinquished as worthless, a constant and remunerative supply of gold can be relied on. It is otherwise, the Author believes, with the true gold mines, those in which the auriferous quartz reef is worked. Here the supply is, as far as we know, unlimited—the assertion that the quartz reefs became poorer in gold as they descend being as yet quite unproved, so that when the due combination of science and capital has been brought to bear upon the subject, there seems to be no reason why the auriferous quartz reef should not be followed as far as any other metal-bearing vein, as in the Cornish tin mines or in the silver mines of Mexico and Peru. Hence the Author concludes that the supply of gold from Australia will probably continue to be large and regular.

In the discussion which followed the reading of the Paper, Mr. Binney, Mr. Hull of the Geological Survey, and Professor Roscoe took part.

Professor ROSCOE remarked, that he believed the chemical investigation of the silurian schist in the neighbourhood of the granite or quartz dykes would probably throw some light upon the dark field of metamorphic actions. We should probably then see that the mineralogical character of the rock had been totally altered by the action of the neighbouring quartz-reef, whilst the chemical composition had suffered little or no change.

Mr. BINNEY stated that Mr. Jevons's description of the Australian gold fields reminded him of the quartz views in the silurian rocks of Seathwaite, near Broughton-in-Furness, in this country, which were auriferous, and which had several times been proposed to be wrought for gold. In Australia, as well as in Lancashire, the quartz views were in silurian deposits in the vicinity of granite; in the latter country near the granitic district of Ravenglass. The size of the quartz views here had prevented their being wrought with success. Had they been as large as the reefs of

Australia, it is most probable that they might have been mined to a profit.

MATHEMATICAL AND PHYSICAL SECTION.

November 10th, 1859.

Mr. T. **Heelis** read a Paper "On Storms, with some attempt to ascertain their tracks in the neighbourhood of the British Islands, and their analogy to other Cosmical Phenomena."

After enumerating several of the points in which observation indicated an analogy between the phenomena of hurricanes and those presented by the gales of high latitudes, and alluding to the barometric waves traced by Mr. Birt, taken in connexion with Professor Dove's theory of parallel compensating surface currents, and the suggestion of Sir John Herschel that rotatory gales are due to the crossing of two atmospheric waves, the Author proceeded to give an extract from Mr. Pennington's seventeenth Memoir, inserted in the seventeenth volume of the Journal of the Asiatic Society of Bengal, showing the action of the cyclone upon the compasses of the bark *Esaurain*, in the China Sea, where the compasses swung round eight points at a time during the squalls. In connexion with this, the Author mentioned that the effect of a gale, apparently cyclonic, upon the compasses of the screw steamer *Victory*, bound from Liverpool to Limerick, on the 30th August last, was to cause a deflection of the compasses.

The Author then mentioned several instances of displays of the *Aurora Borealis* on the passing off of a gale of wind. Three of these were taken from the Greenwich observations for 1847; one from the gale of the 30th August last, above alluded to; and others from other sources—the object in view being to connect the disturbance of the needle observed in these gales with that known to exist during the appearance of *Aurora*.

The Author then proceeded to show the tracks of several storms observed in, or in the neighbourhood of, the British Islands, from which it appeared that they are divided into two classes, one pursuing courses which generally lie to the west of Ireland, and run in a north-north-east direction; and storms of the other class passing nearly along the parallel of latitude. The storms which pass in a north-north-east direction were referred to the north-east branch of the Gulf Stream, and instances were given in which storms, from a movement in a direction a little north of east, had, at the point where the north-east current of the Gulf Stream diverges from the main body, suddenly changed their course and proceeded in a direction parallel to such north-east current. This was shown to be consistent with the observed tracks of hurricanes in other parts of the world, such tracks being usually found near the margin of, and moving parallel to, the great ocean currents.

Numerous instances were given of cyclones following each other in quick succession over nearly the same tracks; also of two cyclones running into one another, and one instance in which a cyclone divided into two.

Mr. Carrington's Papers in the monthly notices of the Royal Astronomical Society upon the connexion between the period of the solar spots and their distribution in latitude, and also upon their drift upon the sun's disk, were then referred to, and it was shown from the Greenwich observations between 1847 and 1857, that as the latitude of the solar spots increased, the average of the tracks of the storms moved north of Greenwich.

The great hurricanes on record from 1760 to the present time were examined, and it was found that, with the exception of a number of storms which are recorded in the years

1840-45 in the Arabian and China Seas and Indian Ocean, all of which occurred near to the Equator, and the increase in the recorded number of which is due to the exertions of Mr. Piddington and Dr. Thom, all the great storms and stormy periods occurred in years immediately adjoining those in which the maxima of the solar spots occurred.

It was also shown that there is a tendency to excessive display of the *Aurora Borealis* about the times of the maxima of the spots, especially about 1837. This had been previously noticed by Mairan, and is borne out by the observations contained in his work on the *Aurora*.

Tables from Mairan's Work and from the Essay of Professor Olmstead on the same subject contained in the Smythsonian contributions, were given to illustrate this point.

Mr. **Baxendell** mentioned that for some days previously to the late gales, the direction in which the storm approached was indicated by the direction in which meteors fell.

Mr. **Dancer** exhibited a photograph of the Moon on glass, taken by him from a small negative obtained by Mr. Hartnup.

Mr. **Mosley** and Mr. **Baxendell** reported the maximum altitude of the barometer on this day (being the time of transit of the great November wave of pressure) as having been at eleven a.m., according to the barometer on the Exchange, 30·62, thermometer 49°; and by the barometer at the Town Hall, 30·63, thermometer 50°. About one o'clock the barometer began to fall.

Ordinary Meeting, November 29th, 1859.

Dr. R. A. Smith, F.R.S., Vice-President, in the Chair.

A letter from Mr. Dyer was read, relative to Mr. Jevons's Paper. Mr. Dyer is led to conclude from the facts which have been ascertained respecting the distribution of gold, that that metal forms a great part of the material of the earth's crust now in an incandescent state.

Mr. F. O. Ward laid before the Society an instrument termed a *Pseudo-diascope*, and a Paper setting forth its construction and use, and the principle it is designed to illustrate. By means of this instrument an aperture transmitting light is made to produce on one eye an isolated impression, while the other eye is directed to an opaque body, such as the hand held before it. The image of the aperture is then found to be transposed, and its perception ceases to be assigned to the eye by which it is really seen; the effect being that a perforation appears in the opaque body, through which the light seems to shine upon the eye by which this is viewed. The principle illustrated by this instrument, according to the Author's view, is the essentially goniometrical and deductive nature of the visual act, whenever the distances of bodies are perceived, and their relative positions in space assigned. A Pseudo-diascope was presented to the Society by the Author, and the singular illusion produced by it was verified by the members present.

Mr. F. O. Ward subsequently laid before the Society a plan of his for diminishing the liability of powder mills to explosion, and referred to a correspondence between himself and Dr. Faraday on the subject. The plan in question consists in supplying to those portions of powder mills in which the powder is treated dry, an atmosphere incapable of supporting combustion—preferably carbonic acid gas—so as to obviate the danger of explosion so far as it arises from chances of ignition *ab extra*—as by the spark from a workman's pipe, of which an example was cited. The danger of explosions from the liberation of oxygen from the powder itself, by friction or otherwise, would of course remain; but this, the Author inclines to believe, is a less frequent cause of explosion than ignition *ab extra* occasioned by the carelessness of workmen, rendered indifferent to risk by long habit, and emboldened by impunity. Dr. Faraday, in his comments on this plan, approves it as adapted to cut off one class of risks, and so to remove the point of danger further off, and also as not likely to deteriorate the quality of the powder immersed in the protective atmosphere. He points out, however, as a source of danger usually unsuspected, the possibility of the ignition of the gunpowder dust which collects on the beams of powder mills, and by which, he believes, explosions may be originated, as well as by the heating of the grains actually under trituration in the mill. Mr. Ward, in reply to Dr. Faraday, recognises the partial nature of the security afforded by the proposed plan, but lays stress on the fact that it appears adapted to eliminate all the risks of the manufacture, except those which are inherent in the nature of the material operated on, and therefore essentially incurable.

A Paper, entitled "Supplementary Researches in the Higher Algebra," by James Cockle, M.A., F.R.A.S., was read by the Rev. ROBERT HARLEY, F.R.A.S.

In these Supplementary Researches the Author extends the elementary formulæ given in § 2 of his original memoir; compares the cyclical and the epimetric views of the function U; and, following the former, is led to a new cyclical theorem which affords an easy demonstration of a proposition asserted in § 28. Mr. Cockle then applies Mr. Harley's cyclical process to the deduction of certain relations between unsymmetric functions; relations attained with a facility which the labour Mr. Cockle formerly expended upon epimetrics well enables him to appreciate. The Author next considers his symbol θ as a rational and symmetric, but otherwise arbitrary, function of four other functions, one of the latter functions, again, being a rational, but otherwise arbitrary, function of four arbitrary symbols, and the remaining three functions being derived from it by the three phases of an interchange which, provided it be of the fourth degree, is otherwise arbitrary. He then expresses the results of all the binary interchanges that can be performed on θ in terms of the single ones (and it should be noticed that from these the results of the ternary and higher interchanges may be obtained), and infers that θ may be regarded as the root of a sextic of which the co-efficients are symmetric functions of the four arbitrary symbols. Mr. Cockle then shows that if we group the six forms of θ two and two, the two members of each group being derivable one from the other by the conjugate interchanges, then the members of a group are inseparable by any interchanges whatever that can be performed upon the arbitrary symbols which enter into θ. So that symmetric functions of symmetric groups may be formed which are unsymmetric in θ, but yet unchanged by any permutations of the four arbitrary symbols. Consequently, if we apply the four arbitrary symbols as multipliers to four of the roots of a quintic, add the products to the fifth root and make the sum a constituent of θ, the symmetric group-function will be a rational function of the fifth root, and therefore the root of a quintic into the co-efficients of which the arbitrary symbols enter symmetrically. In order to give the greatest simplicity to the sextic in θ, the arbitrary symbols may have any suitable values assigned to them, and if we strive after a SYMMETRIC PRODUCT we find that those values are unreal fifth roots of unity. Mr. Cockle adds, that the method of Symmetric Products has no special affinity for any particular theory of equations, and that although the evanescence of the resolvent product brings it into relation with that of Lagrange and Vandermonde, yet that better results may be deduced by applying it to Euler's and Bezout's theory, and without supposing that product to vanish.

A Paper was read by J. P. **Joule**, LL.D., F.R.S., entitled, "Experiments on the Total Heat of Steam."

The Author showed that what is called the total heat of steam, or the quantity liberated when steam is condensed into water of 0° centigrade, consists of, 1st, The true heat of evaporation; 2nd, The heat due to the work done on the steam during the condensation; and 3rd, The heat liberated by cooling the water from the temperature of condensation to the freezing point. The determination of the total heat of steam had been made the object of a very careful and elaborate research by Regnault, but it appeared to the Author that independent experiments conducted in a different and more direct manner would not be without interest. The following is a summary of the results obtained by him, compared with those of Regnault.

Total Pressure of Steam in Inches.	Total Heat in Degrees Centigrade.	
	Author.	Regnault.
37·25	638·43	638·77
57·52	644·77	642·87
111·58	655·45	649·06

A Paper was also read by Dr. **Joule**, entitled, "On a Method of Testing the Strength of Steam Boilers."

The Author adverted to the means hitherto adopted for testing boilers. 1st. That by steam pressure, which gives no certain indication whether strain has not taken place under its influence, so that a boiler so tested may subsequently explode when worked at the same or even a somewhat less degree of pressure. He trusted that this highly reprehensible practice had been wholly abandoned. 2nd. That by hydraulic pressure obtained by a force pump, which does not afford an absolutely reliable proof that the boiler has passed the ordeal without injury, and moreover requires a special apparatus. The plan which had been adopted by the Author for two years past, with perfect success, was free from the objections which applied to the above, and is as follows: The boiler is entirely filled with water. Then a brisk fire is made in, or under it. When the water has thereby been warmed a little, say to 70° or 90° Fahrenheit, the safety valve is loaded to the pressure up to which the boiler is to be tested. Bourdon's, or other pressure indicator, is then constantly observed; and if the pressure, occasioned by the expansion of the water, increases continuously up to the testing pressure, without sudden stoppage or diminution, it may be safely inferred that the boiler has stood it without strain or incipient rupture.

In the trials made by the Author, the pressure rose from zero to 62 lbs. on the square inch in five minutes. The facility of proving a boiler by this method was so great that he trusted that owners would be induced to make those periodical tests, without which, fatal experience had shown that no boiler should be trusted.

MICROSCOPICAL SECTION.

November 21st, 1859.

Messrs. J. G. Lynde and A. Brothers exhibited the process of photographing microscopic objects, as used by them, and which, from the specimens produced, appears very excellent.

The first experiment was the photographing of a thin section of the spine of the *Æchinus;* a $\frac{2}{3}$rds inch object glass of Messrs. Smith and Beck being used, with the focussing glass at a distance of three feet six inches. The object was illuminated with an argand gas lamp. The image being received on an ordinary collodion plate, and exposed for fifteen minutes. The plate was then removed, and presented a beautiful picture of the object, magnified about sixty-five diameters. The results of the experiments altogether, justify the strongest anticipations of future success.

Mr. PARRY described a simple form of camera which he had used, and in which he dispensed altogether with the use of the microscope body; simply inserting the object glass into the lens aperture, and fixing a suitable stage to support the object.

Messrs. LYNDE and BROTHERS stated their intention of attempting to photograph thicker and more opaque objects; and Mr. E. W. BINNEY promised to supply them with sections of fossil woods, which he said had been drawn by artists, but with poor success, as the tendency of draughtsmen was to make them too sharp in outline; the objects losing their characteristic appearance by over definition.

Mr. LYNDE exhibited some fine specimens of *Melicerta*, using for their illumination Wenham's parabolic condenser with excellent effect.

A fine specimen of *Navicula Anceps* was also exhibited by Mr. LYNDE, who succeeded in resolving the apparent lines on their surface into dots with Messrs. Smith and Beck's $\frac{1}{8}$th inch object glass.

Some fine specimens of Ferns were exhibited by Mr. THOMAS BRITTAIN.

ERRATA.—Page 168, lines 27, 31, and 34, *for* views, *read* veins.

Ordinary Meeting, December 13th, 1859.

Wm. Fairbairn, Esq., F.R.S., &c., President, in the Chair.

The President gave an account of "Some Experimental Researches on the Efficiency of Continuous and Self-acting Railway Breaks."

The breaks employed by the Author were those of Mr. Newall and Mr. Fay, which are identical in principle, and consist essentially of a series of break-blocks acting upon every wheel of every carriage throughout the train. These break-blocks are all worked by a single breaksman or guard, by means of a continuous shaft carried the whole length of the train beneath the framing, with suitable jointed couplings between each pair of carriages, so that they may act unimpeded by the jolting of the train or the action of the buffers. Powerful springs also are placed beneath each carriage, and are connected with the rocking shaft, by means of which the breaks are made to act instantaneously throughout the train, on the release of a catch by the guard at either end. The experiments were made by starting, alternately, a train of each description, either by gravity on an incline or by traction, and after having passed a sufficient distance to obtain a measure of uniform velocity, the trains were breaked and brought to rest. The signals for taking time and for breaking were all given by fog signals, and the distance of pulling up was measured with care when the train had come to a stand.

EXPERIMENTS ON THE OLDHAM INCLINE.

Number of Experiment	No. 1 BREAK.			No. 2 BREAK.		
	Velocity of train in feet per second.	Time of stopping in seconds	Distance of stopping in yards.	Velocity of train in feet per second	Time of stopping in seconds.	Distance of stopping in yards.
1	25.71	14	281	25.71	13	153
2	30.00	16	336	30.00	13	250
3	37.50	17	459	37.50	14	360
4	42.85	25	608	41.37	15	499
5	42.85	14	371	40.66	12	326
6	48.38	19	663	48.38	25	739
7	52.94	17	545	50.00	17	575

Reducing the results here tabulated to a common standard, they are found to agree more nearly than at first sight might seem likely. The mean retarding force exerted by the breaks was 125 lbs. per ton weight of the carriages. In these experiments the line was wet and greasy from a thick fog.

The next experiments were made at Southport, on a level line, and upon a dry and frosty day. The mean retardation of the breaks was 298 lbs. per ton weight of the carriages.

The experiments on flap breaks in fine and dry weather gave a retardation of 424 lbs. per ton.

The experiments on slide breaks gave a mean retardation of 425 lbs. per ton.

Hence we may take the mean retardation of these breaks, in dry weather, at 382 lbs. per ton weight of the carriages to which they are applied. This indicates a higher efficiency than that of breaks ordinarily in use, which do not give a greater retardation in similar circumstances than about 300 to 320 lbs. per ton.

Where the rails are wet, however, the retardation is reduced by one-half nearly, and if the weather is foggy and the rails in consequence greasy, the retardation may not amount to more than one-fourth of what it would have been in dry weather.

Now, taking a case in which there would be nearly a maximum advantage in the use of continuous breaks, viz., a train weighing 60 tons, and consisting of an engine weighing 20 tons without breaks, a tender weighing 10 tons with breaks, and a train of five carriages weighing 30 tons, we see that a retarding force of 17,000 lbs. could be called into operation.

If we compare with this, a train of the same weight supplied with only a single break van besides the tender break, the retarding force would not ordinarily exceed 5,400 lbs. Hence, in this case, the advantage of the continuous self-acting break would be in the proportion of 17,000 to 5,400, or more than three to one.

From an average of the whole experiments, it was evident that a train fitted throughout with the continuous breaks, and detached from the engine, might be brought to a state of rest at different rates of speed in the following distances:—

When travelling at 20 miles an hour, in 24 yards.
" 30 " 53 "
" 40 " 94 "
" 50 " 147 "
" 60 " 212 "

This exhibits in a very clear manner the advantages of this class of breaks, in which the whole weight of the train is employed in generating the retarding force required to stop it.

If there were added to the above an efficient break on the engine as well as on the carriages, the whole train might be brought to a stand, when running at a velocity of 50 miles an hour, within a distance of 150 yards.

Mr. David Chadwick drew attention to the improvement of the condition of the working classes since the year 1839, and to the causes to which that improvement was to be attributed.

Mr. J. A. Ransome, F.R.C.S., offered some "Suggestions for the Improvement of the Air Pumps used in Physical and Chemical Researches."

Explanation of the diagram—

Fig. 1.

AA′ BB′. Represent the cylinder, which is to be most accurately bored and polished.

AA′. The top or cover (having a concave surface below), which is to be screwed to the upper flange of the cylinder and made perfectly airtight.

aa. Small tubular apertures communicating between the cylinder and the globular chamber GG′, placed round the tube TT′, and capable of being closed above by the lower surface of the ring UV, forming a valve opening upwards.

BB′. The lower flange of the cylinder, to be attached to the stand, and admitting of a bottom (not airtight) through which works the piston rod PR.

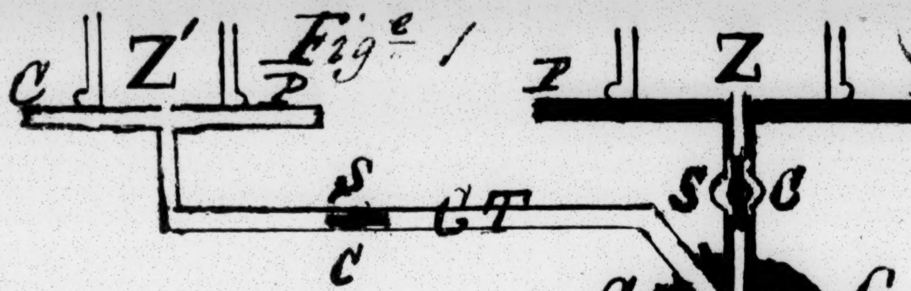
CT. The eduction tube for the passage of air withdrawn from the receiver on the pump-plate PP′; and also for the conveyance of air to the condensing receiver on the plate CP, when the machine is used as a condensing pump.

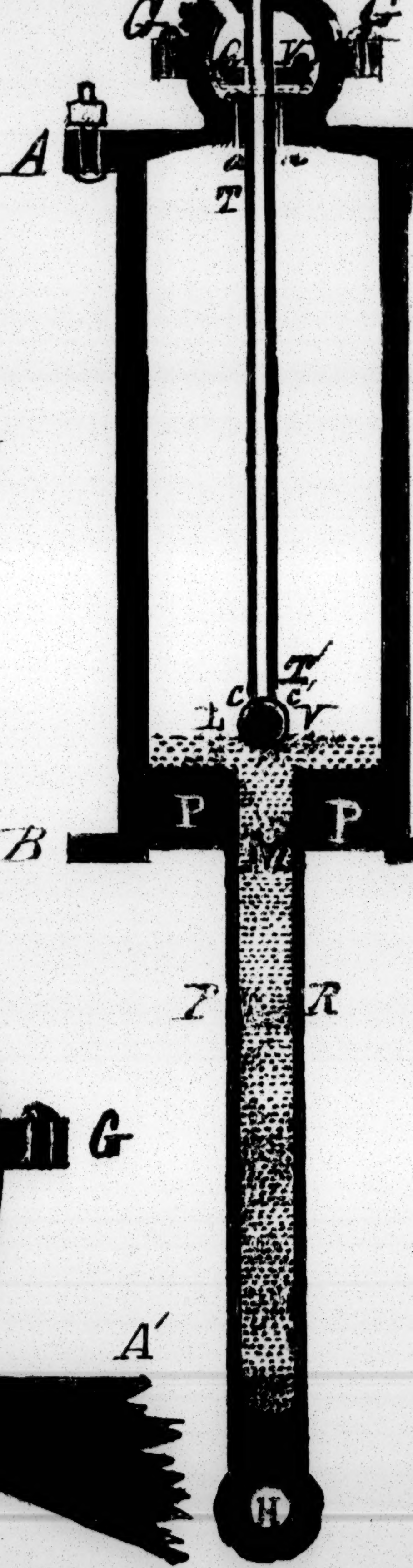
CP. A second plate for a receiver in which air or gas may be condensed, either simultaneously with, or distinct from, the rarefaction on the plate PP′. Such a receiver would require to be secured by a cross-bar and screws, which are omitted in the sketch, as likely to complicate it.

GG′. A globe of two hemispheres joined by flanges. Through this globe passes the tube TT′ from the pump-plate PP′ down to LV (the lower valve); at its lower end a cage, cc′, open at the sides, supports a polished steel ball, which is accurately adjusted to the concave surface of the end of TT, forming a valve opening downwards.

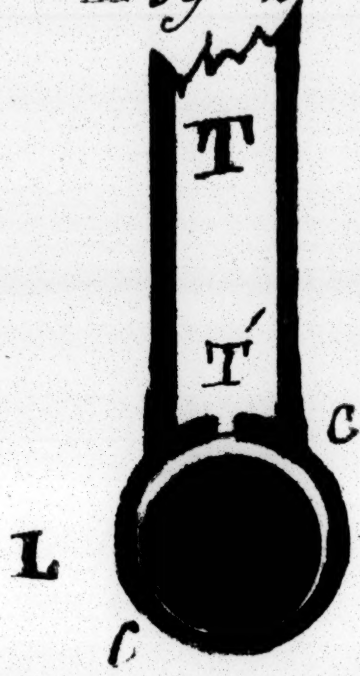
Within GG′ this tube passes tightly through the cover of the cylinder, having a series of small tubular passages around it, until it emerges from the flat bottom of the globe, which is

Fig^e 1

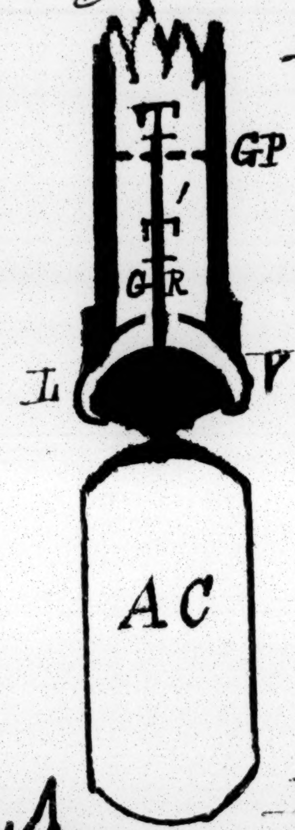




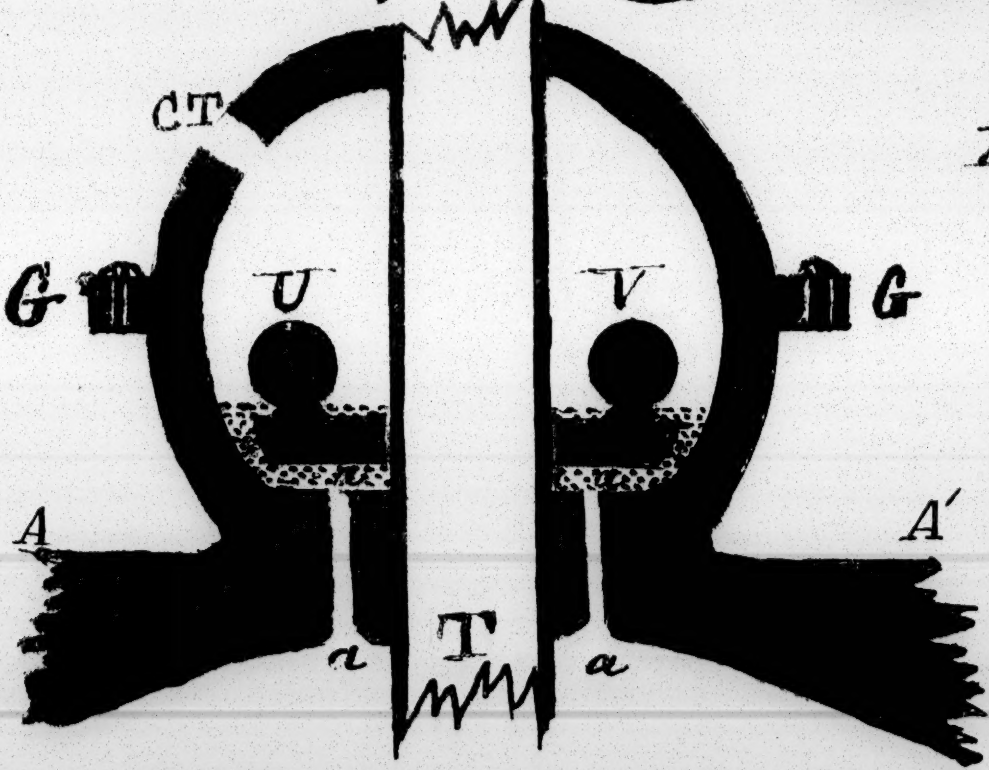
Fig^e 2



Fig^e 3



Fig^e 4



Mr. Ransomes Suggestions for improvements in th
Air pump. — December 13th 1859.

carefully ground to receive the lower surface of the ring UV. This ring falling on the flat surface of the bottom closes the apertures aa when it descends, but permits the passage of air upwards.

Upon the upper surface of this ring are fixed balls (UV either solid or hollow as we use mercury or oil), the uses of which will be explained hereafter.

Through the upper hemisphere of GG′ the tube TT′ passes airtight, and at SC has a stop-cock interposed, above which it terminates in PP′.

LV. The lower valve consisting of a steel sphere pressing upon the concave end of the tube TT′, raised by floating on M, the mercury, and prevented from falling by an open cage which partially surrounds it.

H. The hole for the bolt connecting the lower end of the piston with a lever or any other source of power.

M. The dotted lines indicating mercury or oil in the tubular piston rod PR, the same covering the upper surface of the piston, and the quantity required for the flotation of the ring UV in the globe GG′.

PP. Is a solid metallic piston most accurately fitted to the internal surface of the cylinder.

PR. Is a hollow piston rod attached firmly to the centre of PP, and open at its upper end. Below it is hermetically closed, flattened, and perforated for a bolt, connecting it with the motive power.

PP′. The plate upon which is placed the vessel which is to be emptied of air. SC, stop cocks.

UV. The upper valve contained in the globe GG′ consisting of a flat ring surrounding the tube TT, and fitting accurately upon the flat bottom of the globe and closing its small tubes aa′. ZZ′, receivers.

When mercury is used, the small globes attached to its upper surface are required to sink the lower surface of the ring below the level of the liquid; but when oil is employed these globes must be hollow, and sufficiently buoyant to float the ring from the lower surface.

Fig. 2.

Is an enlarged view of LV, and the letters and references are the same as in Fig. 1.

Fig. 3.

Is a modification of the lower valve LV, when the space M is filled with oil instead of mercury.

AC. Is an air cylinder attached to a hemispherical valve closing the concave end of TT′, as in Fig. 2, but to ensure vertical action there is added—

GP. A guide-plate in TT′, through which passes—

GR. A guide-rod attached to the top of the hemispherical valve LV.

Fig. 4.

Is an enlarged view of UV and the globular chamber which surrounds it. The tube CT in Fig. 1. is omitted, and the aperture to which it may be attached is left open.

The apparatus (thus represented in a skeleton plan) must be properly supported on a stand with some means of communicating motion to the piston rod.

This may be effected by a simple lever, and more effectually if arranged to give a parallel motion.

My suggestion is to attach it to the apparatus proposed by Mr. James White, by which a continuous rotatory motion produces the necessary alternate perpendicular motions essential to its action. *Vide* Century of Inventions, Plate 7.

Assuming that every provision has been made for working the machine, but that no mercury or oil has been introduced into it, we shall commence by supposing that PP, the piston, has been brought up to the top of the cylinder.

The aperture at CT in the globe being open, mercury must now be poured through a funnel into the hole in the centre of the pump-plate PP′, from which it will run down through TT′, LV, and fill the tube of the piston rod PP, and cover the surface of the piston until it ultimately will rise through the tubular openings aa into the lower part of GG′, and so raise the valve ring UV.

At this stage cease to pour in the mercury and make a downward stroke with the piston, and again raise it by an upward movement.

If the level of UV remain the same as before, or even if it should float on mercury, there will be good reason to conclude that sufficient mercury has been poured into it; but if the mercury does not rise sufficiently to float the ring, more must be added in the same manner, moving the piston up and down from time to time, so as to expel bubbles or adherent air.

When satisfied that sufficient has been supplied, place the glass receiver (which I will assume to contain eight ounces of air, and the capacity of the cylinder to be equal to it) on PP′, and make a downward stroke of the piston. At this moment the tension of air in Z, the receiver, and in AB, the cylinder, ought to be equal, and hence one-half the quantity in Z will pass through LV probably during the stroke, but certainly as soon as the steel ball has been left by the sinking of the mercury to fall by its own weight.

Granting that the quantities of air in each are equal, though having only a density equal to one-half of the original, we commence the upward stroke, the steel ball LV is floated against TT′, and reflux is prevented. Soon after the piston has passed half way, its contents are condensed so as to equalise tension with the external air, and thus in the piston's continued course from this point, the ring valve UV is raised until the whole air has passed, and even some small surplus of mercury.

The concavity of the lid, the surface of the piston and the piston rod, are now full of mercury to the exclusion of air, and the next downward movement of the piston produces a vacuity which compels the half residuum in Z again to divide itself between the two chambers through the valve LV, which offers no impediment, as it opens as soon as the mercury sinks below it. One-fourth is now left in Z, and the piston must rise three-fourths of its stroke to enable its one-fourth to effect the lifting of UV, but the residual mercury assists in doing this. I may here remark that we should so adjust the quantity of mercury in GG′ as to allow some to enter after every upward stroke, and some to return before the ring closes on the commencement of each downward stroke. This effected, the two great imperfections of former instruments are obviated, the intervalvular spaces are annihilated, by the liquid valve (the mercury) filling them up; and the mechanical obstacles from adherent or heavy valves are removed by making their own weight efficient in opening them, and thus independent of difference of tension, which, in great rarefaction, becomes too impotent for the purpose.

MATHEMATICAL AND PHYSICAL SECTION.

December 8th, 1859.

Mr. **Baxendell** read a Paper, "On the Rotation of Jupiter."

The appearance of several small, isolated, dark spots on the surface of Jupiter during the last winter and spring, induced the Author to make a series of observations, with the ultimate view of obtaining a re-determination of this planet's period of rotation, and with the more immediate object of testing the conclusions which have been drawn from the observations of Cassini, Sir W. Herschel, Schroeter, &c., to the effect that different spots have different periods of rotation; that the velocity of rotation of the same spot will sometimes vary; and that, in general, spots near the equator move more quickly than those in higher latitudes.

The number of spots observed was *seven*, and they were denoted in the journal by the letters A, B, C, &c.; but the observations of *five* only were sufficiently numerous and exact to be available for the accurate determination of their periods of rotation. Tables are given showing the observed Greenwich mean times of meridional conjunction of the spots A, B, C, E, and F with the centre of the disc, corrected for the changes in the planet's geocentric position and distance. The following values of the mean period are derived from the numbers in these tables:—

	h.	m.	s.		s.
From spot A,	9	55	46.086	±	0.439
,, ,, B,	9	55	44.821	±	0.578
,, ,, C,	9	55	39.240	±	1.650
,, ,, E,	9	55	37.812	±	0.636
,, ,, F,	9	55	39.858	±	1.650

Reference is then made to an interesting series of observations of Jupiter, which had been kindly communicated to the Author by Sir William Keith Murray, Bart., of Ochtertyre, and which, though made without special reference to the question of rotation, had afforded the following mean periods of spots A and B:—

	h.	m.	s.		s.
A	9	55	45.96	±	1.33
B	9	55	43.62	±	1.65

A comparison of the differences between the periods of B, C, E, F, and that of A, and of their probable errors, fully confirms the conclusion drawn from former observations, that different spots have different periods of rotation.

The observed distances between the spots A and B on eleven different nights are given, from which it appears that the distance was greater on January 18th and March 10th than on December 20th and February 2nd; and as the probable error of the mean period of B, derived both from the Author's and Sir William Keith Murray's observations, is greater than that of A, it is inferred that the changes in the distance between the spots were principally due to irregularities in the motion of B. It is also shown from a comparison of the Author's observations of F with Sir William Keith Murray's, that the motion of this spot was also irregular.

Adopting the position of the axis of rotation of Jupiter given in the Introduction to Damoiseau's "*Tables Ecliptiques des Satellites de Jupiter*," the mean result of three nights' micrometrical measures gives the latitude of spot A = 13° 47′ south; and the mean deduced from *fourteen* of Sir William Keith Murray's diagrams is 13° 11′. The spots B, C, and F were all very nearly on the parallel of A, while E, the spot which had the shortest period of rotation, was in latitude 28½° south. It appears, therefore, that the conclusion drawn by Cassini from his own observations, that spots near the equator generally move more quickly than those in higher latitudes, receives no support from the observations discussed in this Paper.

The Author remarks that his results afford no certain information respecting the period of rotation of the planet itself, as distinguished from that of its spots, and he considers that in the present state of our knowledge of the phenomena which take place on its surface, or in its atmosphere, any conclusion as to its exact period of rotation, based upon observations of the times of rotation of its spots, must necessarily be very precarious.

A Paper was also read by Mr. **Thomas Carrick**, "On the Sun's Orbit Plane."

Starting with the assumption that the rotation of the heavenly bodies is inseparably related to their orbit motion by laws of proximate cause, the Author, guided by analogies drawn from known mathematical relations of these motions in the Jovian system, arrived at the conclusion that the point of intersection of the invariable plane of the solar system on the solar equator lies in the orbit plane of the sun.

Adopting the data of Dr. Böhm, of Vienna, the approximate elements of the solar orbit plane for the epoch 1801 would therefore be as under :—

Ascending node on the solar equator ...	248°.9
Inclination on ditto ...	86°.4
Motion when referred to ditto	retrograde.

This plane has singular relations to other phenomena. The axes of rotation of the sun and major planets are very slightly inclined upon it, as under :—

The Sun	3°.6
Jupiter	2°.9
Saturn	6°.8
Uranus	5°.7
Neptune	5°.6

When these rotation axes are projected perpendicularly upon the plane, the angle which the axis of each planet forms with the axis of the sun increases with the orbit distance of the planet, as under :—

Jupiter	4°.0
Saturn	27°.0
Uranus	100°.4
Neptune	151°.5

The plane occupies a mean position among the orbit poles of the planets—the most distant on each side of the plane are :—

The Earth	3°.3
Mercury	3°.2

The plane forms an angle of about 30° with the mean plane of the Milky Way. A line connecting the points of intersection of the two planes coincides with the mean direction of the major axes of all comets.

Any other position of the solar orbit plane would destroy or impair these indications of law.

Ordinary Meeting, December 27th, 1859.

Wm. Fairbairn, Esq., F.R.S., &c., President, in the Chair.

A Letter having been read from Professor Christie, announcing his resignation of the office of Secretary, a resolution was unanimously passed expressing the thanks of the Society for the efficient services he had rendered.

Mr. **Binney** read a short communication, entitled "A few Remarks on the Building Stones used in Manchester."

A stranger visiting Manchester, on having his attention directed to the modern buildings in it, will doubtless notice the substantial nature of the bricks of which they are built. Of the stone employed for building, he will most probably be of opinion that it is not of the most enduring character for the climate and atmosphere it is subject to, and the unfair usage which architects and builders think proper to test it. For however well it may be established in theory, that a sedimentary stone in a building ought to lie in the same position as that in which it was originally deposited in the earth, unfortunately in practice architects will persist in attempting to make the stone accommodate itself to their designs of buildings, rather than design their buildings in accordance with the nature of the stones they have to employ. No doubt beds of stone of great thickness and uniform composition are difficult to find, especially in sedimentary rocks, but still that is scarcely an excuse to place it on its end or at right angles to the planes in which it was deposited.

Of late years a considerable number of experiments have been made as to the strength of building stones, just after they have been taken from the quarry, by pressure. This no doubt will give an idea of their power of resisting force at the time of the experiment being made, but it will give little evidence of the strength of a building stone after some years of exposure to a climate and atmosphere similar to those which the building stones of Manchester are exposed to, without the stone is of a pure silica, or nearly so. In all stones which are subject to chemical decomposition, these experiments will not surely guide us.

Old buildings in country places remote from the smoke and gases of large towns are often adduced in evidence of the strength and durability of a stone to be employed in a manufacturing town. However well the dolomite of Bolsover Moor might endure the climate and atmosphere of Southwell, in Notts, as it is seen in the Minster there, or the triassic sandstone of Furness might endure in the Abbey of that name, each seven or eight centuries, still it would be unreasonable to expect that either of those stones could resist the action of the moist climate of Manchester, and the atmosphere of a city in which about forty thousand tons of sulphur are annually burnt in the coal consumed in it, to say nothing of the gases given off by the numerous chemical manufactories and the exhalations from half a million of human beings.

On examining the buildings of Manchester, we find that the stone employed is chiefly from the middle and lower coal measures, the only instances of triassic or new red sandstones having been used are, as I have been informed, the Portico and St. Peter's Church, from the Oughtrington quarry, near Lymm, and the beautiful church lately built by Mr. Crowther at Moss Side, which is from Hollington, near Ashbourn.

The Cathedral was built from the sandstones of Smedley and Collyhurst, two rocks belonging to the upper part of the middle coal field. These stones are both soft, and contain a large amount of clay and peroxide of iron. As you proceed further down into the middle coal field, you find the sandstones containing less iron in a state of peroxide and considerably smaller proportions of clay, still the stones are not suitable for outside work, as they contain protoxide of iron and sometimes sulphuret of iron, which are scarcely to be seen in the white sandstone when first obtained from the quarry, but on exposure to the atmosphere the iron becomes further oxidized, and the stone "bleeds" and becomes discolored, as well as decomposed. It may be safely concluded that there is no quantity of good building stone, suitable for outside building in a city like Manchester, to be procured from the middle coal field.

The lower coal field and the millstone grit yield the only good building stones for Manchester. These strata comprise the beds lying under the Arley or Royley seam of coal and the limestone shale, and from their being generally found on the high land of the district, are known by the name of "High Moor Stone."

As all the lower coal field and millstone grit beds have most probably been formed of the *debris* of granite or granitoid rocks, we find in them the proportions of silica, alumina, potash, iron, lime, and magnesia generally met with in those rocks. As a general rule the more pure silica the rock is composed of, the better building stone it is. A mixture of mica or clay causes the rock to be more schistose or flaggy, as well as softer. Two chief beds of flags, besides several smaller ones, occur in this division, namely, the upper flag of Upholland, Catlow, and Holy Fold, lying between the Arley and Royley coals, and the lower flag or Bradshaw and Shawforth near Rochdale, lying under the rough rock and above the upper millstone grit. These flag beds yield the stone generally used for par point work.

A fine sharp grained silicious grit is found sometimes above the gannister coal, as at Ending Common near Rochdale, which makes a good building stone.

A stone much used in building is the Halliwell, Woodhead Hill, or Lomax Wood rock, lying immediately under the salts or best coal of New Mills.

The rough rock, generally known as Summit and High

Moor Stone (the upper millstone of the geological survey), a stone much used in building, is of a coarser grain than the stones previously mentioned. It is composed of grains and rounded pebbles of translucent quartz cemented together with partly decomposed felspar and a little iron and manganese in the state of oxide. It is soft when first quarried, and works pretty freely, hardening when exposed to the air. As a building stone it is preferred, owing to its working much easier than the two millstones. Parbold, Horwich, Holcome Hill, Blackstone Edge, and Werneth Low are good examples of the stone.

The upper millstone of Holcome, Bank Lane, Todmorden, Saddleworth, and Tintwistle is a hard and durable sandstone, composed chiefly of silica. It is much harder to work than the rough rock and stands the weather better, but it is not in great use, owing to its being difficult to work.

The lower millstone, as seen at Roecross and Rhodes Wood, Tintwistle, and the lower part of Pendle Hill, contains some excellent building stones, but they are hard to work and therefore have not been much used, but it is, no doubt, one of the strongest and most durable stones of the series. In the lower parts of it are some beds of fine grained sandstone, freer to work than the upper beds. A most excellent bed of this description is found at Bailey, near Ribchester.

In selecting a durable building stone for a town like Manchester, the more silica it contains the better. Iron or manganese in the state of protoxide, or sulphuret of iron as well as clay, all damage the stone. The stones composed of silica cemented with silicates of soda, potash, lime, magnesia, or alumina, are all durable, but when clay or salts of iron form the cement the acids in the atmosphere have a very damaging effect on the building stones containing them.

The sandstones from the lower coal field in the neighbourhood of Halifax and Huddersfield, and generally known by the name of Yorkshire Stone, are much used in Manchester, owing to their good colour and free working qualities. Many of our buildings in which these stones have been used show symptoms of decay, especially in the places where long pieces of stone have been required, and in mouldings and ornamental work.

In some cases the sulphuric acid in the atmosphere has acted on the clay in these stones, and an impure sulphate of alumina having been formed, it is washed by rain out of the stone, and the grains of silica in the latter soon crumble away.

In other instances the water percolates down through the beds of the stone placed on its end until it reaches their bases, and then the frost in winter and the heat in summer expands the water and thus forces off laminæ of stone, in addition to supplying acids to act on the stone as abovenamed.

The under ledges of coping stones, although the stone of which they are formed is placed in its proper bedding, often exhibit evidence of decay. This seems to arise from the moisture percolating the stone and finding its way to the lower parts, which, owing to their being shaded from the sun, are nearly always wet, and thus prepared for the action of frost and heat previously alluded to.

It is surprising to find so small a variety of building stones having been used in Manchester as those above noticed, and it is to be desired that the architects and builders of our city should try other descriptions of stone when they can be had at a moderate price. It is difficult to say how the dolomitic limestones of the Permian group in Yorkshire, like those of Anston, would endure our climate and atmosphere, but so far as my experience goes no instances of them are to be found in our buildings. By the facilities which railways now afford, one might have expected that some of the beautiful syenite of Shap containing large crystals of felspar, or the grey syenite of Bootle and Ravenglass, would have made their appearance in Manchester, but to my knowledge none of them have been used. It is possible that they may not be known to our architects, but most probably the reason why the soft freestones of the coal measures are in such general use is that they are cheap and easily worked. My own impression is, that cheapness is more looked at both by architects and owners of buildings in selecting stone than durability of character.

Some years since a good collection of the building stones of Lancashire was got together and placed in the museum of the Geological Society of Manchester, where they are open to public inspection without charge. This might be increased with stones from the adjoining counties, and then if the architects and builders of Manchester would associate together and devote a little time to the subject, we might expect to find a greater variety of building stones and building stones of great durability than are at present to be met with in Manchester. In conclusion, the Author of these hasty remarks begs to state that it would give him much pleasure to afford such an association all the assistance in his power to discover the most suitable building stone for Manchester.

Ordinary Meeting, January 10th, 1860.

Wm. Fairbairn, Esq., F.R.S., &c., President, in the Chair.

A Paper was read by Mr. Alfred Fryer, entitled "Suggestions for a new form of Floating Lightship, and a mode of estimating the distances of Lighthouses."

Authorities agree that ordinary floating-lights are uncertain, being liable to be drifted from their moorings; they are also frequently injured by storms, and are expensive to maintain.

As the violent action of wind and waves on a considerable surface is the chief cause of mischief, it is proposed to construct a vessel presenting little surface exposed to their influence. The form proposed somewhat resembles a hydrometer, and the material used is wrought iron, the "stem" being surmounted by the lightroom and lantern, and the "bulb" containing the dwelling apartments and store room. The form of the stem is slightly taper, and at its union with the lightroom is only of sufficient width to admit a ladder and the body of a man easily. The length, shape, and strength would vary within certain limits by local considerations. The vessel represented in the diagram and model was one hundred and twenty-five feet long, two-thirds being exposed and one-third submerged. A wide flange, the office of which was to retard and reduce oscillation and vertical motion, was attached to the widest part of the "bulb." The discomfort of living twenty feet below the surface of the water was shown to be small. Some little light could be reflected down the "stem," while quiescence when the water was violently agitated by storms, immunity from the dangers of fire and lightning, and little or no chance of shipwreck or being drifted from the moorings, are advantages not to be forgotten. Ample ventilation could be secured by dividing the stem into ventilating shafts.

Moderate cost, steadiness during storms, and the great elevation at which the light is exhibited, are the chief advantages.

It is proposed to construct lighthouses, in all cases where it is important that mariners should estimate their *distance*, as double lights. The lower light should be exposed in the same tower at a given distance, say fifty feet, and by measuring the apparent distance of the lights apart, either approximately with the eye or accurately with a sextant, the distance can be at once determined.

If Mr. Herbert's proposition for mooring a series of floating-lights along the English and other Channels should be adopted, it is proposed to unite them with each other and with the shore by means of a submerged cable and electric telegraph, so that important information either respecting the lighthouses or vessels in distress can be communicated to head quarters without delay.

[Models of the ordinary form and proposed new form of lightships were exhibited, and on the surface of the water being agitated the motion of the former was considerable, while that of the latter was very slight.]

PHYSICAL AND MATHEMATICAL SECTION.

January 5th, 1860.

A Paper was read by Mr. **Baxendell**, F.R.A.S., entitled "On a New Variable Star (R Sagittæ)."

In the course of a review of some of the telescopic stars in the constellation Sagitta which I made on the night of the 3rd of October last with the achromatic equatorial of Mr. Worthington's observatory, I found that one of the stars was decidedly brighter than I had observed it to be when making a similar review on the 19th of August. I therefore at once placed it on my list of objects for continuous observation, and from the comparisons which I have since made with neighbouring stars on twenty-five different nights, I have ascertained that it is a periodical variable which goes through its changes in about seventy-four days, varying from the 9.8 magnitude at minimum to the 8.4 magnitude at maximum. Its mean place for 1860.0, as derived from comparisons with two stars which occur in Bessel's Zone 192, and with the stars Nos. 1809 and 1810 of the Greenwich twelve-year Catalogue, is R.A. 20h. 7m. 40.1s.; and N.P.D. 73° 41′ 44.5″. Its colour, especially when seen during its maximum with Mr. Worthington's large reflector, is a deep *orange-yellow.*

As this is, so far as I am aware, the first variable yet discovered in the constellation Sagitta, it will, in conformity with Professor Argelander's system of nomenclature, be denoted by the letter R.

The approximate places, and the magnitudes of the stars with which I have compared the variable during its changes, are as follows:—

	Mag.	R.A. 1860.0.			N.P.D. 1860.0.	
		h.	m.	s.	°	′
a	7.7	20	7	37	73	33.7
b	8.5	20	7	17	73	51.4
c	8.8	20	8	30	73	39.1
d	9.1	20	7	32	73	29.8
e	9.1	20	8	1	73	40.6
f	10.0	20	7	15	73	41.8
g	10.1	20	7	58	73	48.5

The magnitudes of these stars were obtained photometrically by the method of limiting apertures, Mr. Pogson's value (2.512) of the ratio of light for a difference of one magnitude being used in the reductions.

The stars *e* and *c* are Nos. 1809 and 1810 of the Greenwich twelve-year Catalogue above alluded to, and I may here remark that there is now no star visible on the place of No. 1811 of this Catalogue. As however there is a 9¼ magnitude star about 1′ 28″ distant to the south, it might be supposed that some error had been made in the observations or reductions; but the Astronomer Royal has obligingly examined the original records, and he finds that all has been correctly entered in the printed volume. It is very probable, therefore, that the object observed was either a small planet having an orbit considerably inclined to the plane of the ecliptic, or a variable star which is at present in its phase of minimum brightness.

Mr. **Heelis** communicated to the Section a notice of an old work on the Origin and Nature of Wind, by R. Bohun, of New College, Oxon, published at Oxford in 1671, and which contains a statement of various points in the law of storms, such as their vortical motion, calm centre, change of currents, and action upon the barometer, twenty-seven years earlier than the earliest account hitherto noticed, which is that of Captain Langford, in the Philosophical Transactions for 1698.

Mr. **Long** exhibited some sketches of the appearances lately presented by the disk of Jupiter, and stated that during the present apparition of the planet he had not observed any dark spots similar to those which were visible last winter.

Quarterly Meeting, January 24th, 1860.

Wm. Fairbairn, Esq., F.R.S., &c., President, in the Chair.

The following gentlemen were elected Ordinary Members of the Society:—Alfred Brothers, Arthur Latham, John Leigh, M.R.C.S., William Cawthorn Unwin, Henry Newall, and William Roberts, M.D.

M. Elias Fries, Professor of Botany at the University of Upsala, was elected an Honorary Member of the Society.

Henry E. Roscoe, Ph.D., F.C.S., &c., Professor of Chemistry at Owens College, was elected one of the Secretaries of the Society.

Ordinary Meeting, February 7th, 1860.

Wm. Fairbairn, Esq., F.R.S., &c., President, in the Chair.

A Communication was read by the President "On the Strength of Iron Ships."

Recent disasters have recalled to recollection numerous defects in the construction of iron vessels, more especially in their powers of resistance to a transverse strain. When we consider the enormous amount of life and property that is at stake, and dependant upon the security of these vessels, it is assuredly a duty to point out the defects in their construction and the remedies which it is necessary should be applied.

Vessels of a length equivalent to eight or nine times their breadth of beam are subjected, when pitching in a heavy sea, to two distinct kinds of strain. First, when rising on the crest of a wave, the ship is supported in the middle with the stem and stern partially suspended; and secondly, when supported at each end and suspended in the middle, as the waves roll under her. In these ever-changing positions it is obvious that her deck, as well as the lower parts of the hull, are subjected to alternate strains of tension and compression; and the tendency is to tear the ship asunder in the middle.

That this does take place is evident, from the fact that both wooden and iron vessels have been known to founder by giving way and breaking asunder. Circumstances may at any time arise when the danger from this source becomes greatly increased. The vessel may be cast ashore, and with the receding of the tide may be left suspended partially out of the water, and remain supported at only one or two points in her length, by ledges of rock. Such cases have occurred, and it has become doubtful, whether our present construction of iron vessels enables them to withstand the shocks and impacts, to which in such a case they may be subjected.

This is not the first time I have applied myself to the inquiry, for the purpose of ascertaining, in the first place, what is the transverse strength of vessels as now constructed; and next, whether the builders of iron ships have been guided in their construction by right principles, and have obtained the greatest strength with the smallest quantity of material. In pursuing this investigation, I have come to the conclusion that our present iron vessels are dangerously weak when exposed to strains of the kind I have indicated; and I believe that this defect of construction may be remedied by a more careful attention to correct principles of proportion, without in any great degree increasing the weight of the vessel.

To ascertain the strength of our present ships, I have supposed them to be placed in the extreme position of danger to which they are ever likely to be exposed; that is, supported at the centre of the vessel on some rock with the ends freely suspended. In this position an iron vessel is, in fact, a wrought iron hollow girder, and we may apply the simple formula, $W = \frac{a\,d\,c}{l}$, by which we ascertain the strength of such constructions.

If we take vessels of the great length of which they are now made, we shall find that they are far too weak along the deck to resist the force of tension, to which, in the position we have assumed, that part is exposed. Taking as an example a vessel of 300 feet in length, built some years ago, I found that she would have given way with four-fifths of the actual displacement of herself and cargo. Taking a vessel constructed according to Lloyd's last rules, and registered A 1 for twelve years, I found her still inadequate to sustain the stress to which she would inevitably be exposed in such a position, the weak part being still the upper deck. I am therefore forced to the conclusion, that a large increase in the sectional area of iron in the upper part of the vessel should be adopted; and the plan I have proposed consists in the introduction of two rectangular and two triangular cells of wrought iron (similar in principle to those in the Britannia and Conway tubular bridges), placed longitudinally under the upper deck of the ship. Cells of this form would increase enormously the strength of that part, and might be adopted without any great modification of the other arrangements of the ship.

In the second place, I am led to recommend the substitution of the new system of chain rivetting along the decks and upper and lower portions of the sheathing, in place of the present weak plan of double rivetting. This change alone would secure an increase of thirty per cent. in the power to resist tension in those parts; and although there are practical difficulties in the way of its adoption, I believe these may, to a great extent, be overcome.

Now, in looking at the principles on which iron ships have been constructed, it will be found that sufficient attention has not been paid to proportioning every part to the strain it has to bear. As now constructed, the iron is distributed almost uniformly throughout the length and uniformly throughout the depth of the vessel, and in this way much material is wasted. In constructions which have to resist transverse strains, economy can only be obtained by collecting the material towards the top and bottom in the transverse vertical section, and towards the centre in the longitudinal section. The longitudinal cells and stringers should be placed as near as possible to the upper deck or the keel as the case may be, and they should be gradually reduced in thickness from the centre towards the ends of the vessel. With the exception of most of the sheathing plates and ribs, which may be left uniform, no more material should be expended upon the intermediate parts, approaching the neutral line, than is absolutely necessary.

With the adoption of this improved system of construction, and a closer adherence to sound principles of design, I am of opinion that greater security may be obtained, and the fearful accidents which have so frequently occurred be greatly mitigated in severity, if not entirely prevented.

A Paper was read by the Rev. W. N. MOLESWORTH, M.A., "On the Politico-Economical Doctrines respecting the Causes which Regulate the Price of Commodities."

The reader of the Paper stated that although this was one of the most important and fully ventilated questions of political economy, it was still a subject on which economists differed. That while Archbishop Whately and most of the elder political economists held that the prices of commodities depend on the proportion between demand and supply, recent writers had put forward the theory that they "are fixed by cost of production and varied by the supply and demand," or as it was otherwise expressed, that "the cost of production was the main and principal cause of the price of any commodity, and supply and demand are the causes of the variation of its price."

The reader of the Paper dissented from these statements of the causes on which the price of commodities depends, first, because they represent, as he thought erroneously, that the price originally fixed depends on one cause and the subsequent variations from that price on another; and, secondly, because they lead to the supposition that cost of production is the direct cause of the price of commodities, whereas the reader of the paper contended that it is only an indirect cause, and in many instances is not a cause of it at all. He maintained that it would be better to say that the proportion between the demand and supply is the proximate cause of the price of an article, but that cost of production is generally, but by no means universally, an indirect cause through the influence which under certain circumstances it exercises on this proportion.

But while he assented to the doctrine of the elder political economists, he recognized the service which had been rendered by the advocates of the new theory in pointing out that the variations of the proportion between the demand and the supply, and through it of prices also, was limited, and generally speaking confined within very narrow limits by cost of production, whereas the language previously used created the impression that they might vary arbitrarily and almost indefinitely.

In the discussion which followed, Mr. CHADWICK expressed his opinion that price is regulated entirely by the relation between supply and demand. Mr. DYER said there could be no doubt that an increase in the quantity of metallic money in circulation must have a great effect on the price of commodities. Mr. TEMPLAR thought that the relation between supply and demand remaining the same, great fluctuations may and do take place in prices which can only be explained by the varying cost of production, and that both supply and demand and cost of production have an influence on price. Dr. SMITH was of opinion that the minimum price of a commodity was a fixed quantity determined ultimately by the cost of a bare living at any particular locality.

A Paper communicated by Mr. BINNEY was then read, "On the Vestiges of Extinct Glaciers in the Highlands of

Great Britain and Ireland," by Edward Hull, B.A., F.G.S., of the Geological Survey. [Abstract.]

The Author commenced by describing the phænomena which induced M. Venetz to announce his opinion of the former extension of the Alpine glaciers considerably beyond their present limits, and proceeded to state that the same appearances as *roches moutonnées*, perched blocks, polished, grooved, and striated rock-surfaces, together with moraines in the British Islands, authorized Dr. Buckland and Professor Agassiz, in 1842, to extend the glacial theory to the mountains of Kerry, North Wales, the Lake District, and the Scottish Highlands.

Mr. Hull then passed these several centres of dispersion for erratic blocks under review, showing the extent of the investigations which their glacial history had received from various authors up to the present time, dwelling more particularly on the Lake District, where the details were principally from his own observations. The results at which he had arrived fully bore out the conclusion of Professor Ramsay, that there have been three distinct periods in the glacial history of these Islands. First, a period when the glaciers extended very far down the main valleys, as those of Coniston, Windermere, and Borrowdale. Second, a period of submergence, when the sea reached an elevation of more than 1,200 feet on the Westmoreland and Cumbrian mountains, and 2,300 on those of North Wales, clothing their flanks with marine Boulder Clay. Third, a period of re-elevation, when the glaciers descended the minor or secondary valleys, ploughing out the Drift, and leaving behind the perched blocks and moraines at present in existence.

The Author concluded by remarking that the great object to be accomplished in reference to this subject was the production of maps, showing the position of the moraines both lateral and terminal, and also the direction of the striæ along the flanks of the valleys of our mountain groups. This had been partially done by Professor Ramsay for North Wales, and M. Hörbye for Scandinavia; a similar map was in preparation by the Author for the Lake District.

Mr. Binney was glad to perceive that the Author of the Paper did not go so far as some geologists, who saw in every accumulation of gravel the traces of an extinct glacier. He thought that the glacial theory, if not carried beyond its proper limits, afforded a valuable means of explaining many geological phænomena.

MATHEMATICAL AND PHYSICAL SECTION.

February 2nd, 1860.

Mr. W. L. Dickinson read a Paper "On the Eclipse of the Sun, July 18th, 1860."

Eclipses of the sun and moon have long been regarded with peculiar interest; not only because of their importance to astronomers and other scientific observers, but on account of the convincing proof they afford to every reflecting mind of the existence of the Almighty Creator, who formed the heavenly bodies by His word, and "hath given them a law which shall not be broken," and who, by the simplicity of the causes which produce the various phenomena of the universe, has manifested to us that "He hath not left Himself without witness."

As the solar eclipse in July next will be of considerable magnitude in England, it is thought that a communication of the results of a calculation made for this city, and of its appearance on the earth generally, will not be unacceptable to the members of the Literary and Philosophical Society. The elements used in the computation are derived from the Nautical Almanac, and have been deduced from Burckhardt's Lunar Tables with corrections by Professor Adams, and from Carlini's Solar Tables with correction by the Astronomer Royal.

ELEMENTS.

	d	h	m	s
Greenwich Mean Time of ☌ in R.A. July	18	2	8	7·1
☉'s and ☾'s Right Ascension		7	52	20·13
		°	′	″
☾'s Declination		N. 21	31	11·7
☉'s Declination		N. 20	57	0·5
☾'s Hourly Motion in R.A.			37	29·4
☉'s Hourly Motion in R.A.			2	30·6
☾'s Hourly Motion in Declination		S.	10	2·3
☉'s Hourly Motion in Declination		S.		26·8
☾'s Equatorial Horizontal Parallax			59	48·5
☉'s Equatorial Horizontal Parallax				8·4
☾'s True Semidiameter			16	20·1
☉'s True Semidiameter			15	46·5

The eclipse of the sun commences July 17^d 23^h 53^m 48^s Greenwich mean time, the penumbra of the moon first touching the earth at sun-rise in lat. N. 34° 43′, long. W. 102° 15′, in Texas; the penumbra, increasing in extent, will spread over the greater part of North America: the central and total eclipse will begin 18^d 0^h 57^m 16^s, at sun-rise in lat. N. 45° 43′, long. W. 125° 47′, near the mouth of the river Columbia; the shadow of the moon, moving in a north-easterly direction over North America, and across Hudson's Bay, leaves the land on the northern shores of Labrador; its course is then in a south-easterly direction over the North Atlantic Ocean, where at 18^d 2^h 8^m 7^s, in lat. N. 56° 9′, long. W. 30° 33′, the sun will be centrally and totally eclipsed at noon; the shadow, continuing its course, crosses the Bay of Biscay, and enters Spain; it moves over the Mediterranean Sea, and passes into Africa near Algiers, and disappears at 18^d 3^h 53^m 10^s, in lat. N. 15° 55′, long. E. 39° 25′, on the borders of Abyssinia and Nubia, near the Red Sea: the penumbra, decreasing in extent, leaves the earth with the setting sun at $18^d\ 4^h\ 56^m\ 38^s$, in lat. N. 4° 16′, long. E. 18° 57′, in the interior of Africa.

The central line enters Spain a little to the west of Santander, and passes near Reinosa, Arnedo, Agreda, Calatayud, Daroca, Calamocha, Montalban, Morella, and Oropesa; every place situated within about 32′, or 37 miles of this line, will experience a total eclipse of longer or shorter duration: the principal places on the north-east are, Bilbao, Espinosa, Vittoria, Logrono, Saragossa, Caspe, Alcaniz, Tortosa, and Peniscola; and on the south-west, Gijon, Oviedo, Burgos, Soria, Almazan, Molina, Teruel, Segorbe, and Valencia: the duration of totality at Reinosa is $3^m\ 35^s$, and at Oropesa $3^m\ 27^s$.

This eclipse will be visible to North America, Greenland, the North Atlantic Ocean, the whole of Europe, the north part of Africa, the west part of Asia, and at the North Pole.

At Manchester, lat. N. 53° 29′, long. W. 2° 14′, a partial Eclipse is visible, and

	d	h	m	s	
Begins	July 18	1	32	44	Mean Time at Greenwich.
Greatest Phase		2	42	30	
Ends		3	48	15	

Magnitude of the Eclipse (Sun's diameter = 1) 0·821 on the Sun's southern limb.

Angle, from North Pole, of first contact, 77° towards the West
Angle, from North Pole, of last contact, 126° towards the East

Angle, from Vertex, of first contact, 98° towards the West
Angle, from Vertex, of last contact, 89° towards the East
for *direct* image.

For any place, not far distant from Manchester, whose geocentric North latitude is l, and East longitude λ, the Mean Greenwich time t of beginning may be computed by the formulæ,

$$\cos \omega = 0{\cdot}87935 - [0{\cdot}19820] \sin l + [9{\cdot}99911] \cos l \cos (\lambda + 73^\circ\ 47'{\cdot}7)$$

$t = 2^h\ 48^m\ 59^s - [3{\cdot}64075] \sin \omega - [3{\cdot}49927] \sin l - [3{\cdot}87655] \cos l \cos (\lambda + 122^\circ\ 9'{\cdot}5)$

Contact on Sun's limb, $\omega - 24^\circ\ 34'{\cdot}8$ from the North towards the West.

Also the Mean Greenwich time t of ending, by the formulæ,

$\cos \omega = 1{\cdot}22601 - [0{\cdot}19621] \sin l + [0{\cdot}00273] \cos l \cos (\lambda + 107^\circ\ 11'{\cdot}5)$

$t = 2^h\ 25^m\ 2^s + [3{\cdot}58835] \sin \omega - [3{\cdot}45937] \sin l - [3{\cdot}82107] \cos l \cos (\lambda + 154^\circ\ 16'{\cdot}6)$

Contact on Sun's limb, $\omega + 25^\circ\ 18'{\cdot}7$ from the North towards the East.

Since the commencement of the preceding calculation, a circular has been issued from the Nautical Almanac Office, dated December 7, 1859, containing a revised path of the shadow, the result of computations from data derived from Hansen's Lunar Tables, and Le Verrier's Solar Tables: in order to give an opportunity of comparing these with the former Tables, and of testing the degree of perfection of each, it seemed advisable to determine the circumstances of the eclipse as it will be seen at Manchester, from elements deduced from the tables of Hansen and Le Verrier.

ELEMENTS.

Greenwich Mean Time.			Moon's Right Ascension.			Moon's Declination.			Moon's Hor. Par.		Moon's Semidiam.	
1860	d	h	h	m	s	°	′	″	′	″	′	″
July	18	0	7	46	57·07	N. 21	52	21·3	59	45·5	16	18·6
		1	7	49	27·40	21	42	33·8	59	46·9	16	19·0
		2	7	51	57·50	21	32	37·3	59	48·2	16	19·4
		3	7	54	27·36	21	22	32·1	59	49·5	16	19·8
		4	7	56	56·98	N. 21	12	18·1	59	50·8	16	20·1

Greenwich Mean Time.			Sun's Right Ascension.			Sun's Declination.			Sun's Hor. Par.	Sun's Semidiam.	
1860	d	h	h	m	s	°	′	″	″	′	″
July	18	0	7	51	58·85	N. 20	57	56·9	8·8	15	44·8
		1	7	52	8·89	20	57	30·1	8·8	15	44·8
		2	7	52	18·94	20	57	3·3	8·8	15	44·8
		3	7	52	28·98	20	56	36·4	8·8	15	44·8
		4	7	52	39·03	N. 20	56	9·5	8·8	15	44·8

The result of the calculation is, that at Manchester the Eclipse

		d	h	m	s	
Begins	July	18	1	34	10	Mean Time at Greenwich.
Greatest Phase			2	43	44	
Ends			3	49	17	

Magnitude of the Eclipse (Sun's diameter = 1) 0·816 on the Sun's southern limb.

Angle, from North Pole, of	first contact,	77° towards the West
	last contact,	126° towards the East
Angle, from Vertex, of	first contact,	97° towards the West
	last contact,	89° towards the East

for *direct* image.

For any place, not far distant from Manchester, whose geocentric North latitude is l, and East longitude λ, the Mean Greenwich time t of beginning may be computed by the formulæ,

$\cos\omega = 0{\cdot}86458 - [0{\cdot}19895] \sin l + [9{\cdot}99885] \cos l \cos (\lambda + 72^\circ\ 27'{\cdot}6)$

$t = 2^h\ 51^m\ 46^s - [3{\cdot}64179] \sin\omega - [3{\cdot}49917] \sin l - [3{\cdot}87835] \cos l \cos (\lambda + 120^\circ\ 55'{\cdot}9)$

Contact on Sun's limb, $\omega - 24^\circ\ 29'{\cdot}2$ from the North towards the West.

Also the Mean Greenwich time t of ending, by the formulæ,

$\cos\omega = 1{\cdot}22453 - [0{\cdot}19671] \sin l + [0{\cdot}00309] \cos l \cos (\lambda + 107^\circ\ 25'{\cdot}9)$

$t = 2^h\ 26^m\ 8^s + [3{\cdot}58745] \sin\omega - [3{\cdot}45878] \sin l - [3{\cdot}82065] \cos l \cos (\lambda + 154^\circ\ 31'{\cdot}3)$

Contact on Sun's limb, $\omega + 25^\circ\ 18'{\cdot}1$ from the North towards the East.

There are four planets in the neighbourhood of the Sun, which may probably be seen during the Eclipse: Venus, within a few hours of her inferior conjunction, will appear as a very thin crescent, having only a minute portion of her illuminated disc turned towards the Earth; this planet is 5° south of the Sun: Jupiter is 9° east, Mercury 25° east, and Saturn 30° east of the Sun.

A Paper was also read by Mr. THOMAS CARRICK "On the Moon's Orbit Plane."

In previous communications the Author has endeavoured to establish a law "that in all systems of cosmical bodies, the equator plane of the primary is the normal of the orbit planes of its satellites."

To this law the Moon's orbit presents the only known exception.

The Author pointed out several respects in which the Moon differs from all other satellites, dwelling especially upon the fact that its gravitation towards the Sun is 2·27 times greater than its gravitation towards the Earth;—a very anomalous position for a satellite of the Earth.

Close analogies were shown to exist between the system of the Earth and Moon and the sidereal systems of revolving double stars.

The abnormal position of the Moon's orbit plane was traced to the action of the preponderant gravitation of the Sun, and this cause was also held to be fatal to the hypothesis of the ellipsoidal figure of the Moon.

Ordinary Meeting, February 21st, 1860.

J. C. Dyer, Esq., Vice-President, in the Chair.

Mr. Hull, F.G.S., in continuation of his observations on the previous meeting, proceeded to remark that when *roches moutonnées* assumed the form of inclined planes or wedges, these forms not only indicated the former existence of a glacier, but also the direction from which the ice had moved, which, as a general rule, was opposite to that of the apex of the inclined plane. An example of this was exhibited in a sketch taken from the valley of Ambleside.

Referring to the opinion of Professor Agassiz, that the Highland Districts had formerly been overspread by broad sheets (*heppes*) of ice, in a manner similar to that of Greenland at the present day, the Author proceeded to show that this opinion was borne out to a great extent by what he had observed in the Lake District. The phenomena in one locality appeared to show that the ice had been in such force and thickness, as to have been forced over a ridge or barrier five hundred feet above the bottom of the valley. He alluded to the flanks of Skelwith Fell, opposite the mouth of Great Langdale. Here the striæ were found to ascend the flanks of this ridge to an elevation of about eight hundred feet above the sea, or five hundred feet above the bed of the valley. They were doubtless produced by the glacier which descended along the valley of Langdale; and instead of turning to the left, and so entering the head of Windermere, the glacier was apparently forced over the opposite ridge.

Mr. Hull considered that this instance of glaciation, as also those at a considerable distance from the central chain of mountains, was attributable to the earliest of the three stages of the glacier period to which he alluded in his Paper; and he proceeded to offer evidence in support of the existence of these three periods, which had been first indicated by Professor Ramsay, when treating of the old Welsh glaciers.

Mr. **Binney** urged the importance of persevering in the work of accumulating facts. Theories long entertained had disappeared with the advance of knowledge. Without denying the existence of such evidences as had been brought forward by Mr. Hull, there were some which had been adduced by geologists which had subsequently been disproved. For instance, it had commonly been believed that the shells in the till were of an Arctic character, whereas those which he had examined in the till of Blackpool and other places, were identical in character with those common in the Irish Sea at the present time.

Mr. **Leigh** exhibited a piece of fossil wood, taken from the clay near Rochdale-road, at a depth of twenty-three feet from the surface. Mr. **Binney** said such specimens were frequently found in Lincolnshire, and were called wire-thorn; the present specimen seemed to be *yew*.

A Paper was read by Mr. T. T. **Wilkinson**, F.R.A.S., "On the Life and Writings of the late Henry Buckley."

At the commencement of the Paper, the Writer notices the fact that the geometers of the North of England have been distinguished for more than a century. Commencing with Jeremiah Ainsworth and ending with Henry Buckley, there are many names in the interval which deserve particular mention. These men were mostly self-taught, and studied mathematics as a recreation. Whether at the loom, or in the mine, they labored on until their abilities became known to the leading men of the day, and their example influenced even the students at our Universities.

Mr. Buckley was one of these self-taught men, who, with some slight assistance from the late John Butterworth, raised himself from obscurity and became distinguished as an able cultivator of the Greek geometry. Towards the close of his life he was in correspondence with most of the able geometers of the day, including Mr. John Whitley and the late Professor Davies. His published Papers contain problems of almost every grade of difficulty, and may be seen in the *Lady's and Gentleman's Diary*, the *York Courant*, and the *Educational Times.*

Since his death most of his manuscripts have been committed to the care of Mr. Wilkinson, who has selected a series of the most curious and interesting to illustrate this Memoir of his late valued friend. Several of the problems relate to the more difficult portions of the ancient geometry, amongst which may be instanced those of inclinations, tangencies, sections of ratio and of space, loci, and porisms. One or two examples are also given of maxima and minima, bisectant axes, besides a series of interesting theorems of considerable interest.

The Memoir closes with a short account of Mr. Buckley's ultimate attainments, his success in life, and the causes which led to his premature death "on the 15th July, 1856, in the 47th year of his age."

MICROSCOPICAL SECTION.

February 20th, 1860.

Mr. **Lynde** exhibited the circulation in the valisneria, and some conversation ensued as to the probable cause of the phenomenon. Mr. Lynde considered that the action of light influenced the movement of the globules more than that of heat, as is generally supposed; for he found the circulation active, in daylight, during cold weather. Mr. Lynde remarked that the motion commenced about ten or fifteen minutes after the exposure of the specimen to a strong light, while the exposure to heat alone would hardly affect it. The point could not, however, be determined, owing to the difficulty of obtaining a powerful light on the object without an elevation of temperature. Mr. **Dancer** thought the movement might be molicular, and similar to that observed in particles of camphor or gamboge in water.

Mr. **Binney** exhibited some specimens of wood, and also some fine sections of canes.

Mr. **Parry** exhibited some excellent microscopic photographs of woods and fossils.

Mr. **Dancer** shewed the spines of the Aphrodita, proving that the prismatic hues exhibited by them were due to the longitudinal lines on their surface.

Ordinary Meeting, March 6th, 1860.

THOMAS HOPKINS, ESQ., Vice-President, in the Chair.

A Paper was read by JOHN GRAHAM, Esq., F.C.S., &c., "On the History of Invention as applied to the Dyeing and Printing of Fabrics. Part 1st, Chemistry."

The Author stated that the elements of a history of the printing of fabrics exist in considerable abundance, but at present they are in a very scattered form. Up to this time the existence had been established of no less than two hundred and fifty works or treatises on the subject, in different languages, in Latin, Italian, German, French, and English. The most of these are accessible, and many are to be found in the British Museum. The authentic records of the Patent Office furnish, also, a rich mine for the historian. Few, on the first consideration, would be prepared to learn that there are existing no fewer than nearly twelve hundred specifications of inventions strictly bearing upon the subject. And there is, lastly, *tradition*, from which much of an interesting character may be expected. Although the field of tradition becomes more and more contracted every year, we may still expect some good fruit from its immediate cultivation. Some traditions are of great antiquity, the knowledge of them very widely spread, and of great interest. For example, a tradition exists in Holland, in France, and the Author had heard of it also from the late Mr. James Thomson, of Clitheroe, namely, that the art of printing books was derived from that of printing of fabrics. It is stated that the first printing of fabrics in Europe was practised by the Dutch at Leyden, and that their knowledge of the art was derived from the East. The patterns of the Dutch were said to be scriptural subjects, with mottoes, cut upon wood, and impressed upon linen. Tradition goes on to state that these blocks were fraudulently obtained from the printers, and applied by others to the printing of paper. Although the Author has put himself in communication with parties there, he has not yet arrived at any distinct corroboration of this curious tradition. The history of invention, however, as relates to the arts of printing fabrics and type printing, gives great weight to the supposition that such was the case, for it is a continuous fact for at least two hundred and fifty years that the art of printing fabrics was the advancing art, while that of paper only followed, and at a considerable distance as regards dates.

In making an attempt to grapple with the scattered elements of this subject, the Author has found it necessary to attack the subject in detail, and for this purpose has proposed to himself to begin with the patented inventions. The material is before one, and the chief duty is selection. Of the twelve hundred inventions connected with printing, of course, the large majority are now of no historical interest. Many of them also are repeats of what had been patented years before. Many are of an utterly puerile character, and some are evidently mistakes or delusions. The attempt to make indigo by fermenting carrots, for example, may with some safety be laid aside as belonging to this latter class.

In this first Paper which the Author laid before the Society, he described the principal inventions relating to Chemistry for which letters patent have been obtained between the years 1617 and 1850.

Among the more interesting of those alluded to, commencing with the grant to George Wood, in 1619, of the sole privilege of printing linen with colours; were the celebrated discovery by Dr. Bancroft of the dyeing properties of quercitron bark; the introduction of the chlorides for the purposes of bleaching by Bourboulon de Boneuil, Crooks, and Tennant; the introduction of manganese brown by Frith, on May 25, 1798; the application of caoutchouc for the purposes of waterproofing, and ornamenting fabrics by means of flocks of different colours by Henry Johnson, in 1797; the use of high-pressure steam for the purpose of bleaching by Turnbull, in 1800; and the more perfect mode invented by Wright, in 1825; James Thomson's celebrated process for discharging the colour from Turkey red cloth by means of an acid and a solution of chloride of lime, in 1813, and his still more celebrated invention of printing metallic solutions on dyed fabrics, and immersing them in a solution of bleaching powder; Joshua Rowe's discovery, in 1818, of the formation of sulphate of alumina by the direct action of sulphuric acid upon clay, aided by a dull red heat; B. Woodcroft's process for printing deoxidized indigo; Mercer, Prince, and Blythe's introduction of the arseniates and phosphates as substitutes for dung; Steiner's process for making garancine from spent madder; Mercer, Greenwood, and Barnes's invention of dry stannates; Mercer and Greenwood's important improvement in the art of dyeing Turkey red, on June 22, 1846; Broguette's process for fixing colours by means of nitrogenous substances aided by steam, in some degree anticipated by Thomas Preston, in 1773; and Mercer and Blythe's introduction of the double salt of arseniate and stannate of soda as a preparation for fabrics.

PHYSICAL AND MATHEMATICAL SECTION.

March 1st, 1860.

Mr. Lowe read a Paper "On a Compound Compensated Pendulum of Steel and Zinc."

A short account was first given of one made at the suggestion of the late Rev. H. H. Jones. The rod of this pendulum was of wood, and the bob rested upon a zinc tube which stood upon the regulating nut at the end of the rod.

The zinc tube passed through a hole in the bob to its centre, so that the expansion or contraction of the zinc tube raised or lowered the centre of the bob, thereby avoiding the irregularities which arise from the expansion of the bob itself in other pendulums. As the bob is a large mass of metal, a change of temperature (which almost immediately expands or contracts the rod and the compensating tube) does not permeate it for several hours; but when suspended by its centre it is obvious that the change of length which takes place when it has arrived at its new temperature, does not affect the rate of the clock, because it expands or contracts equally above and below its centre. If, therefore, the lengths of the pendulum rod and the compensating tube are correctly adjusted, the centre of the bob is kept constantly at the same distance from the point of suspension. The bob used in this pendulum, and the one described hereafter, are neither cylindrical nor lenticular shaped. They are about ten inches long and four wide, with straight sides, and a transverse section would resemble a section of a lenticular bob; thus, the sides terminating in rather sharp edges, very little disturbance is caused in the air confined in the clock case.

Although pendulums made as above described have been tried and found to answer very well in dwelling-houses, they do not appear so well adapted to clocks in observatories. They have been tried at Mr. E. H. Greg's Observatory, at Quarry Bank, and at Mr. Robert Worthington's, at Crumpsall, and irregularities were observed which seemed to arise from other causes than imperfect compensation. Although the wooden rods were carefully selected from dry and straight-grained deal, and protected from moisture by varnish, a change in the condition of the atmosphere, from moist to dry and *vice versa*, was generally followed by a change of rate in the clock.

Mr. Lowe then determined to use steel instead of wood for the rods; and as a much greater length of zinc would be required to compensate for the expansion of steel than of wood, it would be inconvenient to place the centre of the bob upon the upper end of the zinc tube. The latter is, therefore, passed through the hole in the bob, its upper end being about nineteen inches above the upper end of the bob; a brass collar is fixed upon it, from which two steel rods descend (one on each side of the central pendulum rod); two holes are made from top to bottom of the bob to receive them, and they are secured half-way down by screws. Thus, as the zinc expands or contracts, it raises or lowers the centre of the bob as before described; or rather a change of temperature, which causes the zinc tube to expand upwards, causes the steel rods (which are all three suspended by their upper extremities) to expand downwards, and thus the centre of oscillation, which coincides very nearly with the centre of the bob, is kept constantly at one height.

As the centre of the bob of a pendulum to beat seconds of mean time in this latitude should be about 39·14 inches from the point of suspension, the following proportions were found by calculation for the component parts of this pendulum:—

Length of central steel rod, from the bend of the spring to the bearing surface of the regulating nut, 45·37 inches; length of zinc tube, 30 inches.

Length of side rods, extending from top of zinc tube to centre of bob, 22·87 inches.

The proportions of these lengths to one another were determined by Mr. Lowe from data found by experiments upon pieces cut from the steel rods and zinc tube of which the pendulum is made.

Objections had been made to the use of zinc, on the ground of the uncertainty of its ratio of expansion and contraction at different temperatures. Mr. Lowe was, therefore, induced to construct an apparatus by which to ascertain whether this objection was valid. A considerable number of specimens of zinc were examined, but it was invariably found that they expanded with heat and contracted in cooling. Had there been any exceptions to the rule, they must have been detected, for an elongation of one fifty-thousandth of an inch was easily read off; and a tube of zinc, 4½ inches in length, could be observed from a temperature of 0° to 100° centigrade, without removing it from the apparatus; and a change of 10° of temperature produced a change of more than 26 divisions of a scale read off by means of a micrometer.

In the course of a series of experiments made, in conjunction with Professor F. Crace Calvert, upon a number of other metals and alloys, and detailed in a Paper recently read before the Royal Society, it was found that both zinc and steel have a very different ratio of expansion according as they are more or less crystalline in their texture.

Thus, a bar of zinc 2¾ inches long, cast horizontally, expanded for 100° centigrade 216·5.

The same zinc cast vertically, having two axes of crystallization, 257·1; while the forged zinc tube expanded only 150·0.

The differences in steel are not so remarkable.

The same length of steel at a maximum softness,	62·5.
The same bar at a maximum hardness,	84·0.
The same bar tempered so as to be malleable,	61·4.

The steel rods used in a pendulum tested by Mr. Joseph Baxendell, in the Observatory at Crumpsall, expanded 64. The zinc tube 150.

It will be seen by calculation that 29·11 inches of zinc will expand sufficiently to compensate for the expansion of the steel rods, but an addition has to be made on account of a change which takes place in the elasticity of the pendulum spring. It becomes weaker in heat and stronger in cold, and this has the same effect as a little increase or decrease in the length of the pendulum. No rule has, I believe, been laid down as to the exact amount of additional expansion of the zinc tube to compensate for this; but in former experiments with the pendulums with wooden rods, about an inch was required to be added, and in this case 89-100ths of an inch seems to have had the desired effect.

The following is a copy of the rate of a clock at Mr. Worthington's Observatory, fitted up with the pendulum above described.

Date	Sidereal time	Arc of vibration	Clock error	Daily rate	Temperature in the interval	
					highest	lowest
1860.	h m s	° ′	s	s	°	°
Jan. 11	2 12 54·8	2 27	5·8 slow			
14	2 25 59·8	2 32	11·0 ,,	+1·73	39·7	29·5
20	2 38 6·4	2 32	22·5 ,,	1·91	47·0	28·0
29	3 5 2·2	2 32	37·2 ,,	1·63	42·0	19·2
31	2 22 59·8	2 32	40·6 ,,	1·72	39·0	28·5

A small weight was then placed on the top of the bob, to change the rate, and the following results were observed:—

February 6, 6^{h} 20^{m} 42^{s}·1, to February 16, 6^{h} 11^{m} 5^{s}·0, with mean temperature of 29°·1, the daily rate = — 0^{s}·67.

February 16, 6^{h} 11^{m} 5^{s}·0, to February 28, 6^{h} 45^{m} 21^{s}·6, with mean temperature of 35°·1, the daily rate = — 0^{s}·65.

Extremes of temperature during the whole period—maximum = 44°·5; minimum = 16°·5.

Mr. Baxendell, F.R.A.S., read a Paper entitled "Observations of the Zodiacal Light."

The Zodiacal Light has lately been conspicuously visible on clear evenings, extending to an unusual angular distance from the Sun. On February 9, at 8^{h} Greenwich mean time, it was observed to extend to a point about two degrees north of the star ε Arietis, and the intensity of its light in the brightest part was estimated to be about one-third of that of the Milky Way in Cepheus and Lacerta. February 12, at 7^{h} 45^{m}, the apex of the cone of light was about a degree north of the Pleiades; its northern boundary passed over the star γ Pegasi, and its southern five degrees south of Venus. February 13, at 7^{h} 20^{m}, the light could be traced to a point about three degrees east, and half a degree north, of the Pleiades; and the intensity of the brightest part was nearly equal to that of the Milky Way in Cepheus. When compared with the white light of the Milky Way, the Zodiacal Light had a soft ruddy tinge. The breadth of the cone at about 54° from the apex, was estimated to be 18° or 19°. The axis passed over ε Arietis. February 14, at 7^{h} 50^{m}, the Zodiacal Light was broader and brighter than on the previous evening. The brightest portion was about the star ε Piscium, and it was certainly brighter than the Milky Way in Lacerta and Cepheus, but not so *white*. The lower part of the northern side was more extended than had been observed on previous evenings, but this was probably owing to the presence of faint Aurora near the horizon in the north-west. February 16, at 7^{h} 20^{m}, the axis of the Zodiacal Light passed midway between β Arietis and ξ^2 Ceti, and about half a degree north of the Pleiades. The brightness of the light near ε Piscium was estimated to be one-third greater than that of the Milky Way in Cepheus or in Orion and Monoceros. The northern boundary appeared to extend outwards as it approached the horizon, or to have a concave form. The bright light of Venus did not affect the Zodiacal Light beyond a distance of 5° or 6°. February 19, at 7^{h} 30^{m}, the Zodiacal Light extended to φ Tauri. The brightest part was in the triangle formed by the stars ε, η, and ο Piscium, and was nearly, if not quite, twice as bright as the Milky Way in Monoceros and Cepheus. At 8^{h}, the breadth of the cone at 42° from the apex was estimated to be about 13°. Cloudy weather and moonlight have since prevented further observation.

The position of the apex of the cone of light and its angular distance from the Sun on the evenings of observation, were as follows:—

	d.	h.	m.	Long. °	Lat. °	Angular Distance from Sun. °
Feb.	9.	8	0	47	6 N.	87
	12.	7	45	58	5½ ,,	95
	13.	7	20	60	5 ,,	96
	14.	7	50	61	5½ ,,	96
	16.	7	20	64	5 ,,	97
	19.	7	30	65	5 ,,	95

Taking the means of these results, we find that at the epoch February 14^{d} 3^{h} 37^{m}, the apex was 5° 20′ north of the ecliptic, and at an angular distance from the Sun of 94°·3; or considerably beyond the orbit of the Earth.

This great extension of the light merits attention, as occurring at a time when the luminous atmosphere of the Sun is in a state of great activity; and if, as some astronomers suppose, this mysterious phenomenon is directly connected with the Sun, it may reasonably be expected that its extent and brilliance, and possibly also its position, will be influenced by the agencies which produce the Solar spots and the coarse mottling of the Sun's disc; and in this view, the Zodiacal Light may be regarded as the immediate exciting cause of the unusual disturbances of the Earth's atmosphere, which, as Mr. Heelis has very ably shown, generally occur at the times of maximum frequency of the Solar spots.

It is generally supposed that the axis of the cone of light lies in the plane of the Sun's equator, but at the epoch of the above observations a prolongation eastward of the longer axis of the projected Solar equator would pass to the south of the ecliptic at an angle of 2° 30′, and would therefore form an angle of more than *seven* degrees with the apparent axis of the Zodiacal Light. It may, however, be urged that this result is due to the greater visibility of that portion of the lenticular mass of light which is nearest to the Earth, and which, at the epoch of the observations, was on the north side of the plane of the ecliptic.

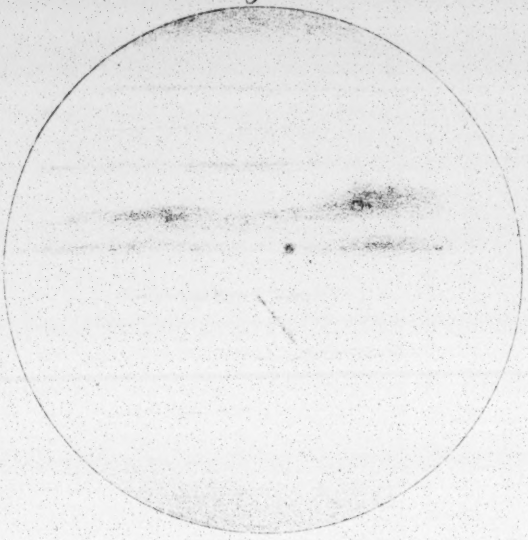
With respect to the remarkable increase of brightness indicated by the observations, I may observe that from the care taken in making the comparisons with the Milky Way, and in noting the state of the atmosphere at the times of observation, I have no doubt of its reality.

Mr. **Long**, F.R.A.S., exhibited a sketch of Jupiter, as seen on February 29th, at 7h 45m Greenwich mean time, showing a small dark spot near the middle of the large dark belt, and a curious streak or belt below the centre of the disc, lying in a direction very considerably inclined to that of the ordinary belts.

Mr. **Williamson** exhibited two photographs of the Sun, one of which had been taken a few hours before the meeting of the Section.

Since Mr. Long drew attention to the curious oblique streak on Jupiter, Mr. Baxendell has twice observed it with the instruments of Mr. Worthington's Observatory, and sketches of its appearance are given in figures 2 and 3 of the annexed plate, from which it will be seen that considerable changes have taken place since Mr. Long's observation of February 29.

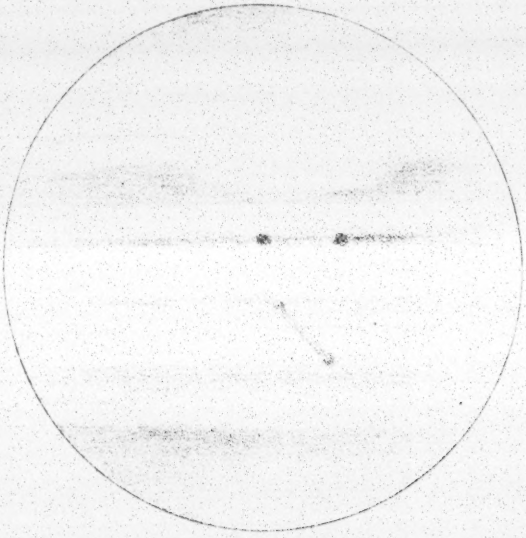
Fig. 1.



1860. Feb. 29
h. m.
7. 45. G.M.T.

Mr. Long. with
5 in. Achromatic
power 305

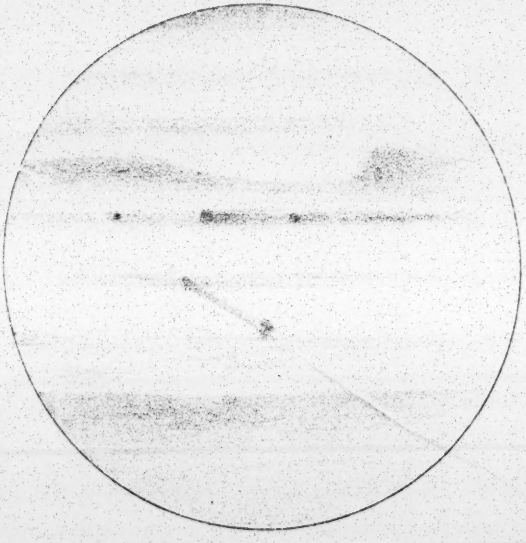
Fig. 2.



1860. March 2nd
h. m.
9. 24. G.M.T.

Mr. Baxendell.
with 5 in. Achromatic
power 223

Fig. 3



1860. March 5th
h. m.
7. 18. G.M.T.

Mr. Baxendell
with 13 in. Reflector
power 301.

Views. of. Jupiter

29 JU60

Ordinary Meeting, March 20th, 1860.

Wm. Fairbairn, Esq., F.R.S., &c., President, in the Chair.

The **President** exhibited two large pans of cast iron, procured by Mr. Worthington from China, where they are used for boiling rice. The metal, which was at the strongest part only one-tenth of an inch in thickness, possessed considerable malleability. The President remarked that the art of making such large castings of thin metal was unknown in England.

Some conversation took place respecting the proposed Telegraph to connect Great Britain with America, by using Iceland, Greenland, and Labrador as intermediate stations.

Mr. F. **Gisborne**, the original projector of the Atlantic Telegraph, said that the fears which had been expressed that the cable would be destroyed on the coast of Labrador by grounded icebergs, were not warranted. He was intimately acquainted with the locality, and although there was an immense number of icebergs which grounded on the coast, some, as he had himself observed, in seventy fathoms water, yet, as at Newfoundland, there were inlets with water in the middle of sufficient depth to secure the cable from injury.

A Paper was read by **John Graham**, Esq., entitled "On the History of Invention as applied to the Dyeing and Printing of Fabrics. Part 2nd, Mechanics."

The Author gave a full account of inventions in printing from the earliest period, of which the following is a brief abstract. The first mention of the application of machinery for the purpose of printing is contained in a grant of patent rights to Arnold Rotespan, in the year 1634, for "a certain pressinge or printinge engine with wheels and rolls, after his peculiar manner." The next great step in advance was the introduction of a printing machine by William Keen and

Moses Platt. This machine, which was patented in 1743, consists of three "bowls" mounted on a frame, one behind the other. Over each bowl is placed an engraved printing roller, and above the rollers are placed feeding rollers for the colour, which by their accuracy of fit and weight act also as "doctors." In 1783, Thomas Bell laid the foundation of cylinder printing, in which a most important improvement was effected in 1796 by William Paul of Manchester, by the introduction of the adjusting wheel, now called the "box wheel." In 1806, Joseph Bramah invented his composite roller, by which the designs which are engraved upon it may be transposed at pleasure, and by which several colours may be printed by one roller.

Professor ROSCOE made a communication to the Society concerning the alleged practice of arsenic eating in Styria. He stated that his object was to settle the long debated question as to the possibility of the human body being able to accustom itself to doses of arsenic, as it is known to be able to do to doses of opium, alcohol, and other substances taken in quantities, which under ordinary circumstances would produce fatal effects. The statement that the peasants of Styria are in the habit of taking doses of arsenic, which would to ordinary persons prove fatal, seems to originate with Von Tschudi. Professor Taylor, in his work on Poisons, places discredit on Von Tschudi's statements, but gives no positive proof concerning the matter. Dr. Roscoe had obtained much information on the subject direct from Styria, through his friend Professor Von Pebal of Lemberg, and the subject was now mentioned simply to call the attention of the members of the Society to the question, and if possible to obtain further definite information. Dr. Roscoe did not venture to express any opinion on the subject at present; he hoped before long to receive conclusive evidence from a circular addressed to the medical men of Styria, the results of the inquiry he would communicate on a future occasion. Mr. **John Graham** remarked that much information on the effects of small and continued doses of arsenic might probably be gained in Manchester, where arsenical preparations were used in so many different manufactures. Dr. **Roscoe** stated that he should feel much obliged if the members could give him opportunity of examining any case of the action of arsenic upon the human body.

MICROSCOPICAL SECTION.

March 19th, 1860.

A communication was read from Mr. **John Hepworth**, of Crofts Bank, accompanying a box of mounted specimens of various kinds of cotton and other fibrous materials.

Mr. Hepworth states that "the average breadth of the cotton cell is about $\frac{1}{900}$th of an inch, except near its attachment, where it gradually tapers to about $\frac{1}{7000}$th of an inch.

"The ultimate fibre of which the cell wall is composed is longitudinal, and inclined in a spiral direction round the tube (? this might arise from position); it is rarely seen, and never, Mr. Hepworth thinks, except with polarised light and good definition. The cell wall in most specimens appears homogeneous."

Mr. **Dancer** presented a bottle of water from his Marine Aquarium, containing large Rotifers and other Marine Infusoria.

Mr. **Brittain** exhibited a specimen of a new mode of mounting large objects in Canada Balsam.

Mr. **Brothers** showed the circulation in Anacharis, Spawn of Snails, Infusoria, &c.

Mr. **Mosley** exhibited some living Marine Animalculæ, from the fosse or inundation at Gibraltar, consisting of Gammarus fluviatilis, Temora, and others, collected by Mr. Frembly of that place.

Ordinary Meeting, April 3rd, 1860.

Wm. Fairbairn, Esq., F.R.S., &c., President, in the Chair.

Messrs. D. Chadwick and J. Atkinson were appointed Auditors of the Treasurer's accounts.

Dr. F. Crace Calvert stated that he had been induced some eighteen months ago, by Mr. J. A. Ransome, to make some researches with the view of ascertaining the nature of the products given off from sloughing wounds, and more especially in the hope of throwing some light on the nature of the contagion known as hospital gangrene. He had, therefore, fitted up some apparatus to condense the various products given off from such wounds, but the quantity obtained was so small, that he deemed it advisable to collect the products given off from a large quantity of meat during putrefaction; and he had found these to be quite of a different nature from what has been hitherto generally supposed. For instance, he found that no sulphuretted nor phosphoretted hydrogen was given off, but, on the contrary, alcaloids containing the sulphur and the phosphorus. He further added that he had great hopes in time to be able to discover the nature of the products called miasms. He also stated that he was now engaged in examining the liquids and solids produced during putrefaction, and would at some future time lay the results obtained before the Society.

Mr. **Henry Bowman** exhibited a chart of the temperature of the last winter months, compared with those of previous years. The principal results are tabulated below :—

	Maximum.	Minimum.	Range.	No. of days on which the temperature fell to or below 32°.	Mean.	Mean of 47 years, from 1794 to 1840, inclusive.	Difference between the Mean of 1859-60, and that of 47 years, 1794 to 1840.	No. of months in same period, with Mean as low as 1859-60.
1859.	°	°	°		°	°	°	
October	73·0	23·5	49·5	8	49·3	50·0	— 0·7	20
November ...	55·3	21·0	34·3	12	40·2	42·9	— 2·7	14
December ...	48·8	9·5	39·3	21	34·2	39·0	— 4·8	3
1860.								
January	55·6	19·0	36·6	15	37·3	36·7	+ 0·6	26
February ...	50·0	18·5	32·5	21	35·4	39·3	— 3·9	4
March	55·0	21·0	34·0	11	40·0	41·8	— 1·8	11
The 6 mos. together.	73·0	9·5	64·5	88	39·4	41·6	— 2·2	

Mr. Dyer having taken the Chair,

The **President** read "A Memoir of the late John Kennedy, Esq."

The subject of this Memoir was born at Knocknalling, in the Stewartry of Kirkcudbright, N.B., on the 4th of July, 1769, and his father (who died whilst Mr. Kennedy was young) was a laird, living upon and cultivating a small farm property. Mr. Kennedy's early educational advantages were very small, as is necessarily the case in remote mountain districts, but he owed to his mother's strong sense those qualities of character which afterwards distinguished him. Pressure of circumstances drove him, at fourteen years of age, to seek in this part of the United Kingdom the means of support which the home farm would not afford. He was apprenticed to Messrs. Cannan and Smith, the machine makers, at Chowbent, in 1784, and at the close of this apprenticeship in 1791, came to Manchester and formed a partnership with Benjamin and William Sandford (then fustian warehousemen) and Mr. James Mc. Connel, under the name of Sandfords, Mc. Connel, and Kennedy, who started in business as machine makers and mule spinners. They were the earliest makers of Crompton's mule, and Mr. Kennedy rendered great service to the new system of mule spinning by the introduction of the double speed, which gave to the thread any amount of twist required, and enabled the spinner to produce much higher counts than had previously been possible. He also carried out improvements in the roving frame, and the differential motion owes much to his sagacity and skill. For many years Mr. Kennedy carried on a series of experiments connected with this motion, and although it has been greatly modified in form and construction since his time, it still bears the impress of his mind, and remains the same in principle as when he experimented upon it.

Mr. Kennedy was endowed with a sound judgment and clear appreciation of mechanical improvements, and the public showed their appreciation of these qualities in his appointment as umpire, in 1830, between the contending parties as to whether the Manchester and Liverpool Railway should be worked by locomotive or stationary engines, and which of the competitive engines in the Rainhill trial deserved the premium offered by the company. It is to his honor that the country is indebted to him for advancing the railway system by his just decision in this case.

As a mule spinner he was successful in all his undertakings, and realized a large fortune. He was a friend of the most distinguished scientific men of his time, and they were constantly to be found at his table. In his business transactions he was a man of sterling honesty, and was very successful, although it is doubtful whether his tastes and talents would have fitted him for the present system of active competition. Mechanical improvements, however, remained his favourite study, and he kept himself acquainted with whatever steps of progress were made during a long and useful life. At the time of his death, on the 30th October, 1855, he was the oldest member of the Society. To its Memoirs he contributed four valuable papers,—"On the Rise and Progress of the Cotton Trade" (1815), "On the Poor Laws" (1819), "On the Influence of Machinery on the Working Classes" (1826), and "A Memoir of Crompton." In these he has displayed consummate judgment and great knowledge of his subjects, although it must be allowed that since his time, his views on the commercial relations and foreign policy of this country have been greatly modified.

Dr. J. P. Joule read a Paper, "On the Efflux of Air."

The Author, after referring to the experiments and views of Newton, Bernoulli, Venturi, Savart, and others, on the flow of liquids and elastic fluids, described some experiments he had recently made on the flow of air through orifices in thin plates, and through tubes. The pressures employed were from 5·6 inches to 1·44 inches of water. The quantity of air discharged was found to observe the well-known law of the square root of the pressure. The Author's experiments on the velocity of air discharged through orifices of different forms were made with a pressure of 1·44 inches. For very small pressures $V=\sqrt{2gh}$; calling this unity the velocity through holes in thin plates, is 0·607; through pipes of diameter equal to their length, 0·767; and through pipes of diameter equal to their length, furnished with a piece of wider tube for the entrance of the air, 0·893.

Dr. Joule also gave results of the boiler testing, by expansion of water, described by him at a previous Meeting, the temperatures employed were between 97° and 126°, and the testing pressure 65 lbs. on the square inch.

A Paper, by Messrs. A. Ransome and G. V. Vernon, was read by Mr. A. Ransome, entitled, "Contributions to Medical Meteorology."

After a short history of the attempts which have been made to connect the prevalence of disease with certain atmospheric conditions, special mention was made of the weekly returns of new cases of diseases furnished by upwards of two hundred medical men to the General Board of Health of London, from April 11th, 1857, to the week ending November 6th, 1858. These returns are accompanied by meteorological observations made at six stations in and out of London, and although in some instances imperfect, the deficiencies are not such as to prevent their use in the present inquiry.

The medical and meteorological returns were projected upon separate charts, so as to form curves, which represent the prevalence of the disease, or the state of the atmosphere at any particular time,* and then by careful analyses of the two series of facts, and comparisons of the two charts, the following conclusions were drawn respecting;

1. *Diarrhœa.* A high mean temperature (above 60°) would seem to have a powerful influence in predisposing to this disease, when continuous, causing a rapid increase in the number of cases. A temperature below 60° appears to be unfavourable to its progress, and these actions are generally most evidently shown, when the temperature is above or below the average of the season.

2. *Dysentery* seems to be influenced by the variations in the mean temperature, but in less degree than diarrhœa, the effect not being generally traced in the lesser undulations of the curve. Increased atmospheric pressure seems to be unfavourable to the progress of the disease, high readings of the barometer being nearly always accompanied by diminished prevalence of dysentery.

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* In each instance of defective return, the probable amount of error arising from this source was marked upon the chart.

3. *Pneumonia* seems to be very greatly influenced by the mean temperature, the disease-curve rising as the temperature falls, and *vice versa.*

4. *Bronchitis* and *Catarrh.* The curve of these diseases, although drawn from ten times the number of cases, is almost identical with that of pneumonia, its highest and lowest points coinciding exactly with those of the pneumonia-curve.

5. *Pleurisy.* This disease is too irregular in its course to yield any information in the present investigation, as the meteorological elements under consideration do not appear to have any apparent connexion with it.

6. *Continued Fever.* It is difficult to trace any connexion between the progress of this disease and atmospheric states; but on the whole, high temperatures seem rather favourable to its production, and extreme cold is probably opposed thereto.

7. *Rheumatic Fever.* The curve of this disease is not sufficiently extended to admit of accurate comparison with meteorological curves, and therefore no satisfactory conclusion can be drawn respecting it.

8. *Measles.* In its chief undulations the measles-curve seems to rise with the fall of the temperature, and *vice versa*, and the influence of this element is best marked when it is above or below the forty-three years average.

9. *Whooping Cough* seems to be much influenced by the extremes of heat and cold, the curve, on the whole, rising with the fall, and sinking with the rise of temperature.

10. *Scarlatina.* A large amount of aqueous vapour in the air appears greatly to facilitate the formation and action of the peculiar scarlatinal poison, especially when this is accompanied by sudden fluctuations in the atmospheric pressure, as shown by the barometer; a diminished pressure being favourable to the disease.

It is rather difficult to separate the influence of temperature from that of humidity, but a moderately low temperature seems to be favourable to the progress of the disease, whilst the extremes of both heat and cold seem often to exert a disturbing influence one way or the other—a temperature above the average generally diminishing, cold increasing the number of cases.

The remarkable supplementary alternations of scarlatina, measles, and whooping cough, were pointed out; and the opinions of other observers, as Hippocrates, Sydenham, Drs. Mühry, Wilde, and Donnelly, were appended to the minute comparison of the curves which followed each proposition.

PHYSICAL AND MATHEMATICAL SECTION.

Annual Meeting, March 29th, 1860.

The following gentlemen were elected Officers of the Section for the ensuing year:—

President, Mr. ROBERT WORTHINGTON, F.R.A.S.

Vice-Presidents, Mr. I. W. LONG, F.R.A.S.
Mr. E. W. BINNEY, F.R.S., F.G.S.

Treasurer, Mr. JOSEPH BAXENDELL, F.R.A.S.

Secretary, Mr. THOMAS HEELIS, F.R.A.S.

Mr. BAXENDELL, F.R.A.S., read a Paper, entitled, "Remarks on the Theory of Rain."

It has been well established by numerous carefully conducted experiments, that the quantity of rain received by a gauge placed on or near the ground is almost invariably greater than that received by a similar gauge placed at a greater elevation in the immediate neighbourhood; and, in explanation of this remarkable fact, meteorological writers have generally adopted the hypothesis advanced by Professor Phillips (Report of the British Association for 1833, p. 410), "that the whole difference in the quantity of rain at different heights above the surface of the neighbouring ground is caused by the continual augmentation of each drop of rain, from the commencement to the end of its descent, as it traverses successively the humid strata of air at a temperature so much lower than that of the surrounding medium, as to cause the deposition of moisture upon its surface." In support of this hypothesis, Professor Phillips remarks "that it takes account of the length of descent, because in passing through more air more moisture would be gathered; it agrees with the fact that the augmentation for given lengths of descent is greatest in the most humid seasons of the year; it accounts to us for the greater absolute size of rain-drops in the hottest months and near the ground, as compared with those in the winter and on mountains; finally, it is almost an inevitable consequence from what is known of the gradation of temperature in the atmosphere, that some effect of this kind must necessarily take place."

Now, although it must be admitted that the temperature of falling rain is generally below that of the air near the ground, yet if we proceed to determine the temperature of a rain-drop at the commencement of its descent, from its known rate of augmentation in falling, and from its temperature when it arrives at the surface of the ground, we shall obtain a result wholly inconsistent with known facts, and therefore fatal to the hypothesis.

The most complete series of observations with which I am acquainted, of the quantities of rain falling at different heights, is that made at York, in the years 1832-5, by Mr. Gray and Professor Phillips at the request of the British Association, the results of which are given and ably discussed by Professor

Phillips in the volume of Transactions of the Association for the year 1835. Three gauges were used in these observations: the first was placed on a large grass-plot in the grounds of the Yorkshire Museum; the second on the roof of the Museum, at an elevation of 43 feet 8 inches; and the third on a pole 9 feet above the level of the battlements of the great tower of the Minster, at an elevation above the ground gauge of 212 feet 10½ inches. The total quantities of rain received by these gauges during the three years of observation were as follows:—

1st gauge	65·430 inches.
2nd ,, ...	52·169 ,,
3rd ,, ...	38·972 ,,

From these numbers it appears that the ratio of increase of size of a rain-drop is 0·679 for the last 213 feet of its fall, and 0·254 for the last 44 feet.

A very able discussion of the whole series of observations, with reference to the temperature of the seasons, led Professor Phillips to the following formula for calculating the difference between the ratios of the quantites of rain received on the ground, and at any height *h*, the value of the co-efficient *p* depending upon the temperature *t′* of the season:—

$$d=p\,h\,\frac{t'}{110}$$

Calculated by means of this formula, the mean height of the point at which rain begins to be formed, is 1747 feet; and the height at which the quantity of rain is only one-half of that which falls on the ground, is 356 feet.

Assuming the mean temperature of newly fallen rain at York to be 48°; and taking the latent heat of vapour at 1210° at the temperature of 32° Fahrenheit—the value adopted by Professor Espy in his Meteorological Reports and Essays,—it will be found that a rain-drop cannot acquire the increase of size indicated by the observations, by the condensation of vapour upon its surface, unless its temperature, when at a height above the ground not exceeding that of the top of the tower of York Minster, is below—434° Fahrenheit! From this result it is evident that only a very small portion of the total augmentation of a rain-drop can be due to the condensation of vapour upon its surface, and that by far the greater portion must be owing to the deposition of moisture which has already lost its latent heat, or heat of elasticity, and which is, therefore, not in the state of a true vapour, although, on the other hand, its invisibility in the atmosphere under ordinary circumstances, in the form of cloud or fog, renders it difficult to suppose that it can be in the ordinary liquid state. We have just seen that at a height of 356 feet, the quantity of rain is only one-half of that which falls on the ground; and it is evident, therefore, that a shallow stratum of the lower and comparatively clear atmosphere, supplies as much rain as a densely clouded, and much deeper stratum in the higher regions. As these remarkable results may raise doubts as to the general correctness of the methods of observation, which have been used to determine the quantities of rain at different heights, I may here mention an important fact, for which I am indebted to my friend, Mr. Binney, F.R.S. In descending the shafts of deep coal mines, Mr. Binney has observed that the drops of water which drip from the upper part of the shaft increase to an extraordinary size during their descent to the bottom. Evidently the same principle is here in operation as in the case of a rain-drop falling through the atmosphere, and Mr. Binney's observation affords a valuable confirmation of the general accuracy of the results of the observations which have been made to determine the rain-fall at different elevations.

That the whole amount of a fall of rain is not derived from the direct condensation of vapour at the time that the fall takes place, is apparent from other considerations than those which depend upon the different quantities of rain at different heights. It is supposed by some meteorologists that the mild temperatures of the higher latitudes of western Europe are due to the heat which is liberated by the condensation of vapour during the frequent precipitations of rain, which take place on or near the coasts; but if this view were correct, the mean temperature of rainy days ought to be considerably greater than the mean temperature of the year.

A discussion of the Greenwich Observations for the years 1852, 3, and 4, and of the Oxford Observations for 1855, 6, and 7, with reference to this point, has given the following results:—

GREENWICH OBSERVATIONS.

YEAR.	Number of Rainy days.	Mean temp. of Rainy days.	Mean temp. of the year.
		°	°
1852	152	51·39	50·66
1853	184	47·62	47·49
1854	145	48·80	48·80
General Means.	160·3	49·27	48·98

OXFORD OBSERVATIONS.

YEAR.	Number of Rainy days.	Mean temp. of Rainy days.	Mean temp. of the year.
		°	°
1855	140	49·84	47·10
1856	154	49·09	48·70
1857	146	49·96	50·40
General Means.	146·6	49·63	48·73

It appears, therefore, that the excess of mean temperature of rainy days, over the mean temperature of the year, on an average of three years, is only 0°·29 by the Greenwich observations, and 0°·90 by the Oxford observations; but as the winds which bring rain come principally from warmer latitudes, the mean temperature of rainy days ought, on that account alone, to be greater than the mean temperature of the year. Dividing the winds into two groups, northerly and southerly, it appears from the Oxford observations that out of 218·5 days of fair weather in the year, the wind was from the northern half of the compass on 131·5 days, and from the southern on the remaining 87; but out of 146·5 rainy days the wind was from the northern half on only 64·5 days, and from the southern on 82. Moreover, the quantity of rain which fell with winds from the southward was nearly four-tenths greater than that which fell with winds from the northward. Calculating the mean temperature of rainy days from the mean temperatures of the winds which prevail on those days, the result is 50°·05; but we have seen that the observed mean temperature is only 49°·63, or 0°·45 less than the computed. It appears, therefore, that a wind accompanied with rain is, in general, sensibly cooler than the same wind attended with fair weather, and that whatever may be the mode of formation of rain it may be regarded as a cooling process; and this view is borne out by the fact that the mean temperature of the days next after days of rain is sensibly less than that of the days of rain. According to the Greenwich observations the diminution is 0°·29, and according to the Oxford observations it is 0°·19. But if the vapour brought by a rainy wind retains its latent heat up to the moment that actual precipitation of rain takes place, the sudden disengagement of this heat, although occurring in the higher regions of the atmosphere, ought to have a very sensible effect in raising the mean temperature of rainy days; but as no such effect is produced we may conclude that the greater portion, if not the whole, of the moisture from which the rain is formed, had previously lost all its latent and also a small portion of its sensible heat.

The questions now arise—1st, What becomes of the enormous quantity of heat given off by the vapour which is condensed in the atmosphere? And 2nd, As the moisture which forms rain is not in the state of a true vapour, is it in the ordinary liquid state, or in some other state not hitherto recognised by meteorologists and chemists? With regard to the first question, it may be remarked that air nearly saturated with vapour, has probably a greater power of radiating heat than dry air. The upper portion of a wind charged with vapour would therefore undergo a rapid cooling, and as the vapour which loses its latent heat does not immediately affect the transparency of the air, this process would go on unchecked for some time, and would gradually extend to the lower strata; the vapour which had lost its latent heat would also gradually descend and accumulate in the lower atmosphere, until at a certain stage of the process clouds and rain were formed. This view of the subject is supported by the well-known fact, that the rate of decrease of the temperature of the atmosphere with the height, is greater in rainy than in fine weather; and it appears likely to lead to a satisfactory explanation of many important atmospherical phenomena.

With respect to the second question, it is difficult to offer any plausible conjecture. There can, however, be little doubt that vapour deprived of its latent heat often exists to a considerable extent in the atmosphere without sensibly affecting its transparency; and, indeed, it often happens that the atmosphere is unusually transparent immediately before, and even during showers of rain, and when, therefore, it is strongly charged with vapour in this peculiar state.

Notwithstanding the cooling by radiation of the upper portion of a warm, moist wind, it is very probable that at a station on the surface of the earth, the temperature would be found to go on slowly increasing, in consequence of the continual arrival of fresh warm air, until the moment when rain began to fall; the rise would then receive a check, and if the rain continued, a decided fall of temperature would take place. If, therefore, we take a day of rain, the day before, and the day after, the difference of the mean temperatures of the day of rain and the day before, ought to be less than that of the mean temperatures of the day of rain and the day after. It will be seen that this conclusion is borne out by the following results of the Greenwich and Oxford observations:—

	Mean temp. of day before Rain.	Mean temp. of day of Rain.	Mean temp. of day after Rain.
	°	°	°
Greenwich Observations..	49·25	49·27	48·98
Oxford ,,	49·50	49·63	49·44

Should the supposition that a considerable portion of the aqueous vapour in the atmosphere may lose its latent heat without becoming visible as cloud or fog be held to be inadmissible, it appears to me that we shall then have no alternative but to conclude that the generally received theory of latent heat is inapplicable to meteorological phenomena,—a conclusion at least as questionable as the view which I have ventured to advance.

Mr. Dickinson read a Paper, "On the Occultation of the Planet Jupiter by the Moon, May 24, 1860."

This phenomenon, as it occurs a considerable time before sun-set, will not be visible to the unassisted eye; such persons, however, as possess good telescopes will have an opportunity of observing it, if the state of the atmosphere will permit; and for the purpose of enabling them to compare their observations with the computed times, the following results of a calculation are submitted to the members of this Society:—

CALCULATION FOR MANCHESTER,

Lat. N. 53° 29′, Long. W. 2° 14′.

	Greenwich Mean time.			Manchester Sidereal time.		
	h	m	s	h	m	s
First contact	4	28	42	8	29	43
Disappearance of the Planet...	4	29	56	8	30	57
Re-appearance of the Planet..	5	39	26	9	40	39
Last contact	5	40	37	9	41	50

Angle, from North Pole, of {first contact 78°
last contact 238°

Angle, from Vertex, of {first contact 95°
last contact 268°

The angles are reckoned towards the right hand round circumference of the Moon's image, as seen in an invert telescope.

Annual Meeting, April 17th, 1860.

Wm. Fairbairn, Esq., F.R.S., &c., President, in the Chair.

The following gentlemen were elected members of the Society:—As Honorary Member: Professor Robert Bunsen, of Heidelberg. As Corresponding Member: Thomas Ainsworth, Esq., of Cleator, Cumberland. As Ordinary Members: George Glover, John Francis, Samuel Clement Trapp, Rufus Dewar Woodcroft, George Stephen Woolley, and the Rev. Joseph N. Pocklington, B.A.

The following Report of the Council was then read by one of the Secretaries:—

Since the last Annual Meeting, a slight increase has taken place in the number of members. The Society contained at that time one hundred and ninety-eight ordinary members. Of these two have died and five have resigned, whilst nine new members have been elected, making the number at present on the list two hundred. Mr. Laurence Buchan, who died in July last year, was one of the oldest members of the Society, having been elected in 1810. For a number of years he was a very regular attendant at the meetings of the Society. The Society has lost three honorary members, Baron Humboldt, General Brisbane, and the Rev. W. Turner. Mr. Turner, who died in April last year at a very advanced age, had been in the Society almost since its foundation. In the second Vol. of the Society's Memoirs will be found a Paper of his, entitled "An Essay on Crimes and Punishments," which was read March 24th, 1784.

Three new honorary members have been elected.

The following Papers have been read during the Session 1859-60:—

October 4*th*, 1859.—"On the Cause of Colour and the Theory of Light," by John Smith, M.A.

October 18*th*, 1859.—"On Irregularities in the Winter Temperature of the British Islands," by Mr. Thomas Hopkins.

November 1*st*, 1859.—"Experiments on the Strength of Cast Iron Girders," by James Gascoine Lynde, M.Inst.C.E.

November 15*th*, 1859.—"Observations on the Gold Districts of Australia," by W. S. Jevons.

November 29*th*, 1859.—"Supplementary Researches in the Higher Algebra," by James Cockle, M.A., &c.

"Experiments on the Total Heat of Steam," by J. P. Joule, LL.D., &c.

"On a Method of Testing the Strength of Steam Boilers," by J. P. Joule, LL.D.

December 13*th*, 1859.—"Suggestions for the Improvement of the Air Pump," by J. A. Ransome, F.R.C.S.

January 10*th*, 1860.—"On a Mode of Estimating the Distances of Lighthouses and Suggestions for a New Form of Floating Lightship," by Alfred Fryer.

February 7*th*, 1860.—"On the Politico-Economical Doctrines respecting the Causes which Regulate the Price of Commodities," by the Rev. W. N. Molesworth, M.A.

"On the Vestiges of Extinct Glaciers in the Highlands of Great Britain and Ireland," by Edward Hull, B.A., F.G.S.

February 21*st*, 1860.—"On the Life and Writings of the late Henry Buckley," by T. T. Wilkinson, F.R.A.S.

March 6*th*, 1860.—"On the History of Invention as applied to the Dyeing and Printing of Fabrics. Part 1st, Chemistry," by Mr. John Graham.

March 20th, 1860.—"On the History of Invention as applied to the Dyeing and Printing of Fabrics. Part 2nd, Mechanics," by Mr. John Graham.

April 3rd, 1860.—"A Brief Memoir of the late John Kennedy, Esq.," by William Fairbairn, F.R.S., &c.

"Experiments on the Efflux of Air," by J. P. Joule, LL.D., &c.

"Contributions to Medical Meteorology," by Messrs. Arthur Ransome and G. V. Vernon.

Of these a number have been ordered to be printed in the Memoirs. Some are still under the consideration of the Council. Of those which are to be printed, several will be found to be of great value and importance.

The Council has determined to close the second series of the Society's Memoirs, which commenced in the year 1805, and consists of fifteen volumes. The forthcoming volume will accordingly be the first of the third series.

Since the last Annual Meeting a mathematical and physical section has been formed among the members. The reports of its proceedings have been issued at intervals along with those of the Society. The establishment of a section for statistics and sociology has also been sanctioned by the Council, but it is not yet formally constituted.

The Council has adopted a scheme to regulate the relations which are for the future to subsist between the Society and its various sections. To this scheme the sections at present existing have expressed their adherence.

It was resolved by the Council, in the name of the Society, to join with the other Societies and Institutions of the city in inviting the British Association to hold its meeting for 1861 in Manchester. The invitation was presented at the meeting of the Association at Aberdeen last year, and was favourably received.

It will be seen from the Treasurer's balance sheet that whilst the income of the Society has remained almost stationary, the expenditure on the other hand has been rapidly increasing, an evil which will very soon require remedying, since the reserve fund held by the Society is of only a trifling amount.

A committee has been appointed by the Council to take into consideration a general revision of the rules of the Society.

[illegible] ORMEROD, TREASURER, IN ACCOUNT WITH THE LITERARY AND PHILOSOPHICAL SOCIETY OF MANCHESTER,

Dr. FROM 12TH APRIL, 1859, TO 20TH MARCH, 1860. **Cr.**

		£.	s.	d.	£.	s.	d.
To Balance in Bank of Sir B. Heywood and Co., 12th April, 1859		102	9	2			
,, Ditto in the hands of Treasurer		37	1	6	139	10	8
,, Arrears of Subscriptions 1857-8,	No. 2	2	10	0			
,, Ditto ditto 1858-9,	11	13	15	0			
,, Subscriptions 1859-60,	173	216	5	0			
,, Ditto 1860-1,	1	1	5	0			
,, Half Subscriptions	6	3	15	0	237	10	0
,, Admission Fees	9				18	18	0
,, Vol. XV. sold		1	10	6			
,, Other Memoirs sold		2	8	6			
,, Interest allowed by Bankers		1	14	3			
,, Repayment by Photographic Society		4	10	0	10	3	3
,, Donations, Library Special Fund		3	13	0			
,, Subscriptions, Special to Library		20	0	0	23	13	0
,, Sectional Contribution—Physical & Mathematical.		2	2	0			
,, Ditto Microscopical		2	2	0	4	4	0
					£433	18	11

	£.	s.	d.	£.	s.	d.
By Chief Rent	12	8	7			
,, Fire Insurance	4	17	6			
,, Property Tax	6	7	6	23	13	7
,, Water Rent	1	1	0			
,, Gas	4	1	0			
,, Candles	1	2	0			
,, Coals	6	14	10			
,, Cleaning	1	16	3			
,, Furniture	0	10	0			
,, Repairs	1	5	8			
,, Receipt Stamps	0	3	0	16	13	9
,, Keeper of the Rooms—Salary				60	0	0
,, Tea and Coffee, &c. for Members				17	14	0½
,, Postage and Parcels	20	13	1½			
,, Printing and Stationery	18	15	6	39	8	7½
,, Printing Proceedings	25	9	4			
,, Memoirs, Printing, Engraving, &c.	94	16	0	120	5	4
,, Library—Books purchased				26	1	10
,, Library Special Fund—Binding, &c.				32	3	6
,, Keeper of the Rooms for attendance on Sections.				4	4	0
,, Photographic Society for attendance				2	10	0
Total Disbursements as by Cheque and Voucher Book				£342	14	8
March, 1860.—By Balance in the Bank of Sir B. Heywood and Co.	49	18	9			
Ditto in Treasurer's hands	41	5	6	91	4	3
				£433	18	11

HENRY M. ORMEROD, TREASURER.—March, 1860.

Library Special Fund	16	11	0
Library Special Subscription	20	0	0
General Balance	54	13	3
Total Balance	£91	4	3

Audited and found correct,

DAVID CHADWICK, } AUDITORS.
JOHN ATKINSON, }

April 3rd, 1860.

LIBRARIAN'S REPORT.

Since the close of last Session 259 vols., 227 parts of vols., and 178 pamphlets, have been added to the Library; of these 15 vols. and 27 parts being by purchase, and the remainder by donations or exchange with other Societies.

The publications which the Librarian is authorised to purchase remain the same as specified in the last Report.

The sum of £22. 12s. obtained for this year by voluntary subscription of ten shillings per annum from forty members, and donations from two, will probably be best disposed of in completing as far as possible the binding of the books.

A new catalogue is in preparation.

On the motion of Dr. **Calvert**, seconded by Mr. **Fryer**, the Report was adopted.

The annual election of officers then took place, when the following gentlemen were elected:—

President.

JAMES PRESCOTT JOULE, LL.D., F.R.S., &c.

Vice-Presidents.

WILLIAM FAIRBAIRN, F.R.S., INST. NAT. SC. PAR. CORRESP.
ROBERT ANGUS SMITH, PH.D., F.R.S., F.C.S.
JOSEPH CHESBOROUGH DYER.
EDWARD WILLIAM BINNEY, F.R.S., F.G.S.

Secretaries.

EDWARD SCHUNCK, PH.D., F.R.S.
HENRY ENFIELD ROSCOE, B.A., PH.D., F.C.S.

Treasurer.

HENRY MERE ORMEROD.

Librarian.

CHARLES FREDRIK EKMAN.

Of the Council.

JOSEPH BAXENDELL, F.R.A.S.
JOSEPH ATKINSON RANSOME, M.R.C.S.
REV. WILLIAM GASKELL, M.A.
RICHARD ROBERTS, M.INST.C.E.
PETER SPENCE.
FREDERIC CRACE CALVERT, PH.D., F.R.S., F.C.S., &c.

It was proposed by Dr. JOULE, seconded by Mr. BAXENDELL, and carried unanimously, "That a vote of thanks be given to William Fairbairn, Esq., for his able conduct as President during the past Session."

29 JU 60

&c.

Baxen-

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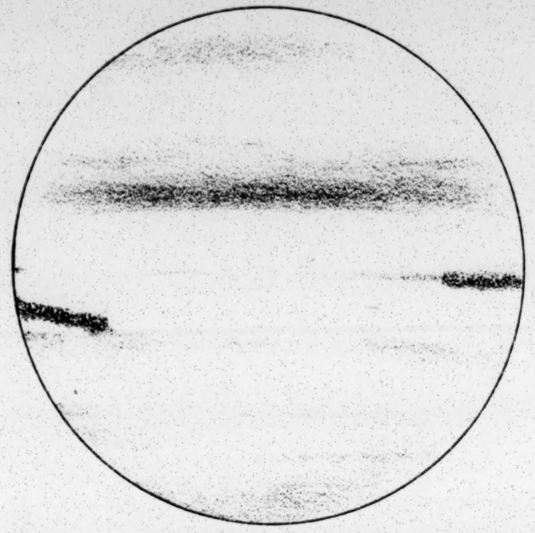
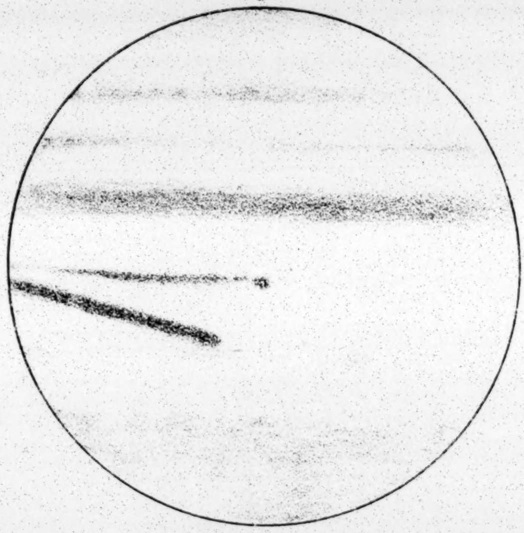
Fig. 4.



1860. April 22nd
h. m.
8. 25. G.M.T.

Mr. Baxend
with 5 in. Achro
power 223

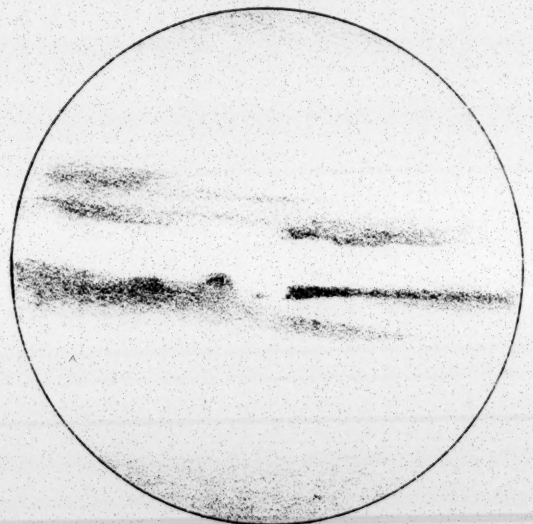
Fig. 5.



1860. April 24th
h. m.
9. 20. G.M.T.

Mr. Baxendell
with 5 in. Achrom
power 223.

Fig. 6.



1860. May 6th
h. m.
8. 40. G.M.T.

Mr. Long
with 5 in. Achrom
power 374.

Views of Jupiter.

PHYSICAL AND MATHEMATICAL SECTION.

April 26th, 1860.

Mr. Baxendell, F.R.A.S., read a Paper, entitled "Observations of the Oblique Belt on Jupiter."

Since the publication of the lithographed sketches of Jupiter, taken by Mr. Long and myself on February 29, March 2, and March 5, showing the position and appearance of a curious oblique streak or belt on the disc of the planet, this streak or belt has increased greatly in size and darkness, and has become an object of considerable interest, as showing very strikingly the extent and rapidity of the changes which sometimes take place on the surface, or in the atmosphere, of this magnificent planet.

On March 7, the spot at the lower end of the oblique belt was perceptibly larger and darker than on the 5th, and was in the middle of its transit across the disc at 8h. 54m., Greenwich mean time. March 12, this spot was central at 8h. 1m.; the belt itself was darker and less inclined than before to the ordinary belts, and it was darkest on its lower edge. The lower part of the large dark belt was more nearly uniform in shade, and there was no decided appearance of dark spots in it.

March 14, 8h. 45m. I observed Jupiter with Mr. Worthington's 13-inch reflector, power 301. There was a faint, curved, dark mark extending across the bright equatorial belt from the upper end of the oblique belt to the small spot shown in the preceding part of the large dark belt in my sketch of March 5, and which, though now invisible with the 5-inch achromatic, is clearly made out with the large reflector. There were also traces of projections on the bright equatorial belt from two other points in the large dark belt. The spot at the lower end of the oblique belt was central at 9h. 41½m., Greenwich mean time.

March 21. The oblique belt had increased considerably, and the spot at its lower end was much larger and appeared to consist of two spots in contact.

April 5. The following part of the oblique belt had undergone a considerable change, and had now three spots or rather large patches upon it much darker than the rest of the belt.

April 9. The oblique belt now extended over more than a semi-circumference of the planet, as it was seen at 8h., Greenwich mean time, extending completely across the disc. Its extremities were, however, still on the same parallels of latitude as when first observed by Mr. Long.

April 20. The preceding end of the oblique belt was in its central position at 8h. 23m., Greenwich mean time. It was much darker than the rest of the belt, and was estimated to be two or three times darker than the darkest part of the large belt. Its colour was also very remarkable, being bluish black when contrasted with the dull yellowish red colour of the large dark belt.

From the observation made this night, it appears that since Mr. Long first observed the oblique streak on February 29, it has gradually extended itself in a preceding direction, or in the direction of the planet's rotation, with a mean velocity of 3,640 miles per day, or 151 miles per hour; its two extremities nevertheless remaining constantly on the same parallels of latitude.

Fig. 4, taken April 22, at 8h. 25m., Greenwich mean time, shows the two ends of the oblique belt on opposite parts of the disc, the preceding end coming on and the following end going off.

April 24, at 9h. 20m. The following end of the oblique belt was in the position shown in Fig. 5, in which it will be observed that the faint narrow belt upon which the upper end of the oblique belt rests, has increased in breadth and darkness in the portion immediately over the lower part of the latter belt, and has a faint spot upon it nearly central at the time the sketch was taken.

Last night, April 25, a remarkable dark patch on the oblique belt was in the central position at 8h. 40m.: it was darker than the rest of the belt, and darker than any portion of the large southern belt. There was still the same contrast of colour, the oblique belt appearing to be bluish black when compared with the dull yellowish red of the large belt.

Mr. HEELIS, F.R.A.S., read a Paper "On the Observations of the Sun made by Hevelius in the years 1642—3."

The Author laid down the spots observed by Hevelius in the above years in a similar manner and upon the same scale as the charts of the solar spots made by Mr. Carrington, and communicated by him to the Monthly Notices of the Royal Astronomical Society.

From these he deduced the conclusion that at the time at which the observations were made the sun was fast approaching a period of minimum activity, which period he fixed as having in all probability occurred about the middle of December, 1644, and this period was shewn to be consistent with the statements of the observations of the spots mentioned in Lalande's "Astronomie" and Keill's "Introductio ad veram Astronomiam."

From the old observations, it appears that at the beginning of the eighteenth century there was a remarkable deficiency of maxima, inducing the suspicion that the period of the spots, or rather of the maxima of the spots, has a secular variation as well as the short cycle evidenced by the observations of Mr. Schwabe, although no range of observations has, as yet, been sufficiently prolonged to determine the period of such secular variation.

The observations of Hevelius show a decided tendency in the spots, as the time of minimum frequency approaches, to group themselves near the Solar Equator, as has been ably pointed out by Mr. Carrington, in his paper above alluded to; and also a preponderance of action in the southern hemisphere of the sun.

There is also a remarkable burst of activity in the action by which the spots are produced shortly before the period which the author fixed as that of minimum frequency.

Eight instances were collected from the observations on which the preceding number of a group of spots was the largest, in accordance with the law suggested by Mr. Baxendell in his Paper "On certain Phenomena of Groups of Solar Spots," read before this Section during the last Session.

One clear instance of rotatory motion of a spot was also noticed, the motion being from east to south, and the angle of rotation 71°·5.

Several instances of the motion of groups of spots upon the disc of the sun, may also be gathered from the observations.

May 25th, 1860.

The following observations of the Occultation of Jupiter by the Moon, on the 24th instant, were communicated by Messrs. Worthington, Dancer, and Baxendell :—

	Mr. Worthington.	*Mr. Dancer.*	*Mr. Baxendell.*	
	h. m. s.	h. m. s.	h. m. s.	
First contact......	4 29 51 ...	4 29 47 ...	4 29 53·4	G. M. T.
Second ——......	4 30 53 ...	...	4 30 56·2	——
Third ——......	Not observed.			
Fourth ——......	5 41 49·5 ...	5 41 49 ...	5 41 52·1	——

Mr. Worthington observed with his Newtonian reflector of 13in. aperture, power 81; Mr. Dancer with an achromatic reflector of 4in. aperture, equatorially mounted in his Observatory at Ardwick; and Mr. Baxendell with Mr. Worthington's achromatic equatorial of 5in. aperture, power 68. The sky in the neighbourhood of the moon was covered with white cirrous haze, and all the observers remarked that the images of the moon and planet were very unsteady. No distortion of the image of the planet was noticed; but Messrs. Worthington and Baxendell remarked that at the disappearance of the planet the last point of light lingered for one and a-half or two seconds before its final extinction. Mr. Baxendell also observed that during the passage of the dark limb of the moon over the planet, the light of the planet's disc was sensibly *brighter* close to the moon's limb than at any other part; but when the planet emerged at the moon's bright limb that portion of its disc immediately adjoining the moon's limb was decidedly *darker* than the rest.

Mr. Baxendell reported that after April 20 the oblique belt on Jupiter increased in length at a rapidly increasing rate, and that on May 6 it was observed both by Mr. Long and himself to extend completely round the planet, the preceding end slightly overlapping the following as shown in Fig. 6, taken from a drawing made by Mr. Long. From February 29, the date of Mr. Long's first observation of the belt, to April 20, the average rate of increase had been 3,640 miles per day; but from April 20 to May 6, the average rate had increased to 5,460 miles per day, or 227·5 miles per hour!

MICROSCOPICAL SECTION.

April 16th, 1860.

The Secretary read a Paper, by Mr. Hepworth, "On Preparing and Mounting Insects."

Mr. Hepworth first destroys life by sulphuric ether, then washes the insects thoroughly in two or three waters in a wide necked bottle; he afterwards immerses them in caustic potash or Brandish's solution, and allows them to remain from one day to several weeks or months according to the opacity of the insect; with a camel-hair pencil in each hand, he then in a saucer of clean water presses out the contents of the abdomen and other soft parts dissolved by the potash, holding the head and thorax with one brush, and gently pressing the other with a rolling motion from the head to the extremities to expel the softened matter: a stroking motion would be liable to separate the head from the body. The Author suggests a small pith or cork roller for this purpose. The potash must afterwards be completely washed away, or crystals may form. The insects must then be dried, the more delicate specimens being spread out or floated on to glass slides, covered with thin glass and tied down with thread. When dry they must be immersed in rectified spirits of turpentine, placed under the exhausted receiver of an air pump. When sufficiently saturated they will be ready for mounting in Canada balsam, but they may be retained for months in the turpentine without injury. Before mounting, as much turpentine must be drained and cleaned off the slide as possible, but the thin glass must not be removed, or air would be re-admitted. Balsam thinned with chloroform is then to be dropped on the slide so as to touch the cover, and it will be drawn under by capillary attraction. After pressing down the cover, the slide may be left to dry and to be finished off. If quicker drying be required, the slide may be warmed over a spirit lamp, but not made too hot, as boiling disarranges the object. Vapours of turpentine or chloroform may cause a few bubbles, which will subside when condensed by cooling.

Various specimens, beautifully mounted by this process by Mr. Hepworth, were exhibited.

Mr. **Mosley** read an account of a Microscopical Examination of Flour, illustrative of the commercial advantages which may be occasionally derived from a knowledge of the use of the instrument.

Mr. **Dancer** exhibited Diatomacea and Foramanifera, obtained from deep soundings in the Atlantic and from the Red Sea.

Mr. **Lynde** exhibited pupa cases of Insects, from the Gold Coast of Africa.

Mr. **Hepworth** sent for inspection an ingenious diatom box, constructed for a friend going to travel on the Continent.

Annual Meeting, May 21st, 1860.

The following Gentlemen were elected Officers of the Section for the ensuing Session:—

President, Professor W. C. **Williamson**, F.R.S.
Vice-Presidents, E. W. **Binney**, F.R.S., F.G.S.,
W. J. **Rideout**,
Joseph Sidebotham.
Treasurer, J. G. **Lynde**, M. Inst. C.E., F.G.S.
Secretary, **George Mosley.**

Mr. **Lynde** presented two slides of pupa cases of Insects, called Gold Shells, from the Gold Coast of Africa. He also exhibited the circulation of the blood in the tail of the Stickleback.

Mr. **Latham** presented to the Section, and also to each member present, a portion of Sand, from Aden, in the Red Sea, containing Foramanifera, Spicula, &c.

Mr. **Dancer** exhibited a number of Slides of various new and interesting objects.

June 20th, 1860.

The **Secretary** read a few extracts from a private letter from Mr. Frembly, of Gibraltar, in which he refers to the rotifera found in that neighbourhood: they vary very little from the British species described by Carpenter, Henfrey, &c. He found with them, free vorticella with spiral stalk or tail, whilst in England the free vorticella is generally found without tail. Its utility in the case of those living with such neighbours is manifest, for the vorticella would now and again become involved in the eddy made by the cilia of the rotifera, but invariably before coming in contact did they succeed in escaping by the muscular power of the tail, which by suddenly coiling enabled them to throw themselves out of the influence of the current.

Mr. Frembly had found one of the Algæ of the chlorosperma order, which was new to him, and of which he had not found any description. He intends to send specimens for examination.

A letter was read from Mr. Hepworth, of Crofts Bank, accompanying specimens of Sarcina, injected kidney, spores of Equisetum, Euglina, Batrachospermum monaliformis of two kinds, some diatoms, &c.

Mr. **Samuel Hardman**, of Davyhulme, presented a few well mounted specimens of larva, wire-worm, willow cotton, cimex, and curculia.

Mr. **Mosley** exhibited the living (so-called) skeleton larva and pupa of the corethra plumicornis (Pritchard), pupa of Ephemera, marine gammarus from Gibraltar, and aquatic gammarus from near Northenden, almost identical with each other; the shell or scales of the marine animal being most transparent. A question was asked by Mr. Mosley, if any of the members had observed the effects of placing marine animals in fresh water; two of the gammari, born in sea water, were transferred to fresh water, and their liveliness as exhibited after four days of the change, was as great as in their native element. Members were requested to acquire information on the subject, and communicate the same, as it is rather an important matter to owners of marine aquaria living at a distance from the sea.

Mr. BROTHERS exhibited the tongue of a cricket, circulation in the chara, &c.

Mr. DANCER sent for exhibition a specimen of Topaz, with natural cavities containing fluid and gases, which on boiling present curious phenomena; also a box of objects, two microscopes, &c.

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